THE BEAMA JOURNAL

MAY 1960

Part of a representative display at the Ideal Home Exhibition

A QUARTERLY REVIEW OF
BRITISH ELECTRICAL AND ALLIED ENGINEERING

Special Feature in this issue: Domestic Appliances

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Cover Illustration. *The stand of the Electrical Development Association at the Ideal Home Exhibition included a display of practically every type of British domestic electrical equipment. Our illustration shows one aspect of the stand—a section devoted to electric cookers. Other parts of the display are illustrated on pages 72 to 74.*

Editor: **John Dyer**

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A QUARTERLY REVIEW OF BRITISH ELECTRICAL AND ALLIED ENGINEERING

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A Year of Achievement

Under this very appropriate title the Forty-ninth Annual Report of the BEAMA reviews the progress of the British electrical industry for the year 1959–60. As it is a matter of wide general interest and importance, we quote this part of the Report in full.

'It has become axiomatic for the electrical industry each year to establish new records and 1959 was no exception. The output of the electrical and allied manufacturing industry reached a value around £1 400 million and was about 9 per cent above the previous year. The most significant advance was made in the production of domestic electrical appliances, the output of which during the first three-quarters of the year exceeded the whole of the 1958 figures. Many appliances reached the highest level yet in their volume of production. Striking increases were achieved in such products as washing machines and refrigerators, and new products, such as spin dryers, which have only been on the market for a comparatively short time are already making an important contribution to the total volume of output and to the development of the domestic electrical load.

'On the heavy electrical plant side, the outstanding feature was the record level of steam turboalternator deliveries which totalled almost 4 000 MW. Both the total production and the amount delivered for export were higher than in any previous year. The trend towards larger individual units was reflected both in plant delivered and in orders placed. The plant commissioned during the year by the Central Electricity Generating Board included the first unit of 200 MW, and the orders during the year included the 300 MW and the 350 MW sets which are the largest single shaft designs planned so far. The second 550 MW cross-compound set was ordered during the year for the new station at Thorpe Marsh and will be the largest of its type in the world.

'At the other end of the scale a development of considerable interest was the commissioning at Princetown in Devon of a 3 MW completely automatic generating set powered by a Bristol Proteus turbo-prop engine. This, the first remote controlled peak load power station in the United Kingdom, may well provide a prototype for export purposes.

'The electrical manufacturing industry retained its position as a leading exporter with a total of £285 million, representing over 10 per cent of Britain's total export of manufactured products. This was £9 million higher than last year and £6 million higher than the previous record export achievement in 1957. Many important overseas orders were won during the year, including contracts for 300 MW generating sets for Canada and 200 MW sets for Australia.

'This general pattern of growth had its counterpart in the electricity supply industry, which with a total of 98 941 million units sent out, showed an increase of 6·7 per cent over the previous year and was in line with the well-established trend for the demand for electricity to double every ten years.

'The year also showed the first fruits of British Railways long-term electrification plans and the first operational 25 kV electric locomotive was put into service.

'These are some of the highlights of a year of considerable achievement and they indicate the soundness and vigour of the electrical industry and its vital part in the national economy.'

Another event of considerable importance dealt with in the Report is concerned with the testing and approval of household electrical appliances.

Proposals for establishing a suitable body to carry out these functions have been under discussion for some years, but largely as a result of the efforts of B E A M A's Domestic Appliances Board a new scheme has been agreed with the electricity supply industry, the British Standards Institution, electrical contractors, wholesalers and retailers, and a provisional British Electrical Approvals Board for Domestic Appliances has now been established which will institute procedures for testing of appliances and the issue of a suitable approval mark. The scheme will cover imported, as well as home-produced, appliances.

The British Domestic Appliances Industry

This issue of THE BEAMA JOURNAL turns the spotlight on the growth and development of the domestic electrical appliances industry in the United Kingdom—an industry which has in recent years made tremendous strides and is now achieving an annual turnover in the region of £200 million.

It may come as somewhat of a surprise to many people in the electrical business today to learn not only that vacuum cleaners are as old as this century, but that they were a British invention; that electric cooking was commercially available even before the end of the 19th century, and that there was a public restaurant in London in the 1920's equipped exclusively with electric cooking equipment and energetically used as a practical means of publicising what was then a new idea.

These, and many other interesting aspects of the development of the British domestic appliances industry, are brought to light in the articles in this issue which have been specially contributed by some of the leading manufacturers in this field, and which survey—albeit briefly—the main items of equipment in use today. As always in surveys such as this, these articles must be regarded as representative rather than exhaustive; broad pictures rather than detailed studies.

Some of the external factors which have profoundly influenced the progress of the industry, both beneficially and adversely, are touched on by most of our contributors, but other factors have also operated, particularly in the earlier years, as formidable obstacles to be overcome in winning the wide public acceptance of domestic electric equipment which would provide the foundation for large-scale manufacture.

The early years of electricity supply in Great Britain were marked by a multiplicity of supply undertakings, each serving its own area and presenting an almost bewildering range of supply voltages, both d c and a c, and a widely varying range of consumers' tariffs. In such circumstances, dispersion rather than concentration of manufacturing effort was unavoidable.

Again, the majority of Great Britain's population lived in old houses, many of them built long before the era of electricity, and therefore either unwired for any electricity supply, or else wired on a meagre scale for lighting only and, more often than not, totally unprovided with socket outlets for any other electrical equipment. Other countries, especially those with extensive natural power resources for electricity generation and more modern housing facilities, have perhaps been more fortunate.

The outlook in the United Kingdom has, however, undergone sweeping changes in the last two decades. Probably the most important factors have been the unification of the electricity generating and supply system, the standardisation of the supply voltage and frequency, and the universal distribution of power through the national grid and the Area Board networks. Coincident with these benefits has been the ability of the supply industry to hold the average cost of electricity to the consumer to a figure only about 35 per cent above the pre-war price—an achievement which, as we have pointed out before in these columns, has been largely due to the great improvements in generating efficiency achieved by the manufactures of steam-raising and generating equipment.

With a resilient home market to support it, the British domestic appliances industry is intensifying its efforts in the export field. The reception accorded to the British exhibits at this year's Cologne Hardware Fair—the first time a British section had been organised at this event—augurs well for the future, and there is no doubt that from all points of view—design and styling, reliability and efficiency, quality and safety—the British domestic appliances industry has much to offer to buyers and users overseas.

The articles mentioned above were arranged in consultation with the BEAMA Domestic Appliances Division, the member-firms of which are:

A D A (Halifax) Ltd
A E I-Hotpoint Ltd
Aidas Electric Ltd
Allied Ironfounders Ltd
Associated Electrical Industries (Manchester) Ltd
Backer Electric Co Ltd
Baldwin, H J, & Co Ltd
Belling & Co Ltd
Berry's Electric Ltd
Bertram Thomas (Engineers) Ltd
Best Products Ltd
Bestfrend Electrical Co Ltd, The
Bray, George, & Co Ltd
Bulpitt & Sons Ltd
Burco Ltd
Carron Company
Chilton Electric Products Ltd
Corfield-Sigg Ltd
Dimplex Ltd
Dixon, R G, & Co Ltd
E K C O Heating (E K Cole Ltd)
Easipower Appliances Ltd
Electrix Ltd
Electrolux Ltd
Electroway Heaters Ltd
English Electric Co Ltd, The
Falk, Stadelmann & Co Ltd
Frost, H, & Co Ltd
General Electric Co Ltd, The
Goblin (B V C) Ltd
Gramophone Co Ltd, The
Heatovent Electric Ltd
Heatrae Ltd
Hoover Ltd
Horstmann Gear Co Ltd, The
Hurseal Ltd
Hydran Products Ltd
Isopad Ltd
Kenwood Manufacturing (Woking) Ltd
Lan-Bar Ltd
Leicester Battery Co Ltd
Limit Engineering Group Ltd
Low, Duncan, Ltd
Midland Electric Manufacturing Co Ltd
Miller, Gordon, Ltd
Modern Electric Industries Ltd
Morphy-Richards (Cray) Ltd
National Pressure Cooker Co (England) Ltd
Parkinson Cowan Appliances Ltd
Perihel Ltd
Philips Electrical Ltd
Price, T, & Sons (Stampers) Ltd
Electrical Division of Radiation Ltd
Remploy Ltd
Revo Electric Co Ltd
Rollnick & Gordon Ltd
Rowlands Electrical Accessories Ltd
Rubery Owen & Co Ltd
S L R Electric Ltd
Santon Ltd
Simplex Electric Co Ltd
Siroma Engineering Co Ltd
Smith, W H, (Eziot) Ltd
Thermega Ltd
Thorn Electrical Industries Ltd
Universal Boilers and Engineering Co Ltd
Walsall Conduits Ltd
Warm-Glow Co Ltd

Canberra—The Liner of a New Decade

THE ss *Canberra*, the P & O Company's 45 000 ton passenger liner designed for service in the Pacific, was launched on 16 March, 1960. She is the largest and fastest British liner built since the Queens, and her advanced design presents a challenging solution to the problems of rising building costs and competition from airlines. Appropriately, the launching ceremony was performed by Dame Pattie Menzies, wife of the Prime Minister of Australia.

The main features of the ship are increased speed and comfort. Both are brought about by the greater use of electricity. *Canberra* is the largest ship in the world equipped with turbo-electric propulsion; the operating voltage of 6 kV is higher than that used previously on merchant ships, and she is the largest merchant vessel equipped with an alternating current system for auxiliary services. The installed capacity of nearly 70 MW makes her a floating power station; and, in several aspects of design, power station techniques have replaced marine practice.

The *Canberra* should be completed in the late spring of 1961. When she joins the *Oriana*, which will be ready for service at the end of 1960, the two ships will form the nucleus of a British passenger fleet for Pacific trade. Both vessels are half as large again as the vessels at present in the fleets of their owners. Increases in building costs have made it impossible to replace the first post-war liners with vessels of a similar size and still make a profit. *Canberra* (£15 million) is costing about 50 per cent more per ton than *Iberia* (£6½ million), launched in 1954. Therefore the P & O Company decided to build larger vessels and to extend their Australian service to link Australia, New Zealand, Hong Kong, Japan, and the West Coast of North America. Such an increase in length of voyage brings in its wake the need for faster ships to reduce travel time. Thus the *Canberra* was designed for a speed of 27½ knots, compared with the 22 knots of the liners at present operated by the company. The effect of the increased speed is to cut the journey time from London to Sydney from nearly four weeks to three weeks.

Apart from the requirements of speed and comfort, the other important consideration governing the design were the size limits of the Suez Canal and the restricted facilities at some of the proposed ports of call. The dimensions adopted were as follows:

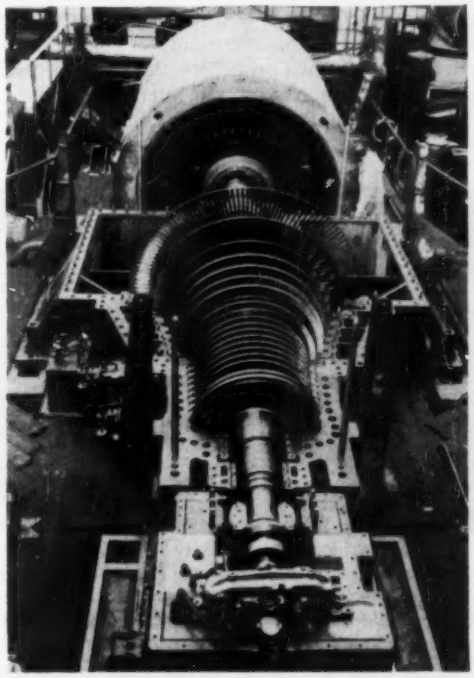
Length overall	820 ft (250 m)
Length bp	740 ft (226 m)
Breadth	102 ft (31 m)
Draught, maximum	32 ft 6 in (9.9 m)
Height, load line to bridge	108 ft 6 in (33 m)
Gross tonnage	45 000 tons
Number of passengers:	
1st class	600
tourist	1 650
Crew	1 000

The Boiler Plant

In the *Canberra* the main engine rooms are situated in the stern of the ship. This enables the centre of the ship, where the motion is least, to be used for passenger accommodation without the intrusion of funnel trunking. Location of the engines aft also reduces the noise level in the passenger areas. So much so that special acoustic treatment has had to be provided for cabin walls to reduce domestic noises, which in the absence of blanketing by engine noise become particularly irritating. The slim funnels aft make an important contribution to the distinctive appearance of the vessel.

Associated Electrical Industries (Rugby) Ltd are supplying the turbo-electric propulsion equipment. Although this type of drive has a higher first cost, takes up more space, and weighs more than simpler alternatives, the fuel consumption is no greater and certain advantages are obtained. The need for astern turbines is removed; greater flexibility of operation is achieved; and it becomes possible to run the propellers locked in any required phase relationship. This last property of the drive is of great value in a ship like the *Canberra* which depends for its success on the comfort of the passengers. The periodic forces that excite principal or local modes of vibration in the hull can be reduced to a minimum by correct phasing.

Three oil-fired Foster Wheeler external superheater D-type boilers supply steam to the two main 32·2 MVA turbo-alternator sets. The boilers are probably the largest fitted in any British ship. Each of the three main units has



One of the two propulsion turboalternators in course of erection at the A E I Rugby works. Each is rated at 32·2 MVA CMR, 3 087 rev/min, 6 kV, 1·0 pf

a maximum output of 260 000 lb/hr (118 000 kg/hr) and the single standby unit is capable of 50 000 lb/hr (22 700 kg/hr). For normal operation the outputs reduce to 175 000 and 40 000 lb/hr (79 300 and 18 100 kg/hr). Steam conditions of 750 lb/in^2 (52·7 kg/cm^2) and 960 deg F (515 deg C) were chosen as the limit for satisfactory superheater operation with commercially available fuel.

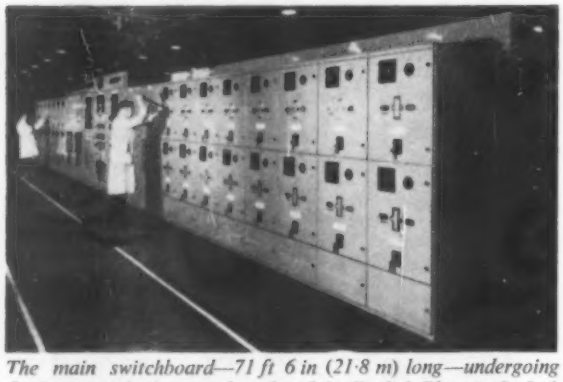
Chemical treatment of boiler feed water has also been eliminated to a great extent. An ion-exchange technique is to be used with water obtained from a single distillation of sea water. The equipment will use a safe alkaline reagent, which is cheap, and sea water. Carbon dioxide and all mineral salts will be removed, leaving only a small trace of oxygen. This will be removed in the de-aerator and condensate distiller.

The Weir sea-water distillation plant to be installed consists of 6 vertical evaporator shells, each with 1 050 ft^2 (97·5 m^2) of heating surface. Domestic, culinary, and boiler requirements are fed from the same plant, which has a maximum output of 750 tons in 24 hours. Scale is minimised in the plant by the use of Thermoflex heating elements, which expand and contract with slight variations in temperature and pressure. Cost is kept down (10 pence per ton) by the use of low-grade steam.

The Propulsion Turbo-Alternators

The main engine room is situated just forward of the boilers. Two main turbo-alternator sets are housed there and they normally power two double-unit propeller motors. Some 68 000 shp at 136·5 propeller rev/min for normal service; maximum continuous output is 85 000 shp at 147 rev/min. Full ahead power is available astern. For powers up to 85 000 shp, the port double-unit propeller motor is connected to the port turbo-alternator, and the starboard motor to the starboard turbo-alternator. Below 40 000 shp, both propeller motors can be connected to either turbo-alternator, for greater economy. To synchronise the two propellers, the two forward half-motor units are connected to one alternator, and the two after half-motor units to the other.

The main propulsion turbines have 17 stages each and



The main switchboard—71 ft 6 in (21·8 m) long—undergoing final tests at the Liverpool works of the English Electric Co Ltd. It will control the complete power supply throughout the ship and is the largest a c marine switchboard ever built in the U K for a passenger or merchant vessel

are uni-directional single cylinder machines. Twin governors are provided: the first holds turbine speed at 25 per cent of full speed during synchronisation of the propeller motor; the second is adjustable from 85 per cent of full speed to above maximum service speed, when it is available as a pre-emergency governor. An emergency governor trips out at 10 per cent overspeed. Electrically operated barring gear is fitted.

Bellows couplings connect the turbines to the three-phase two-pole alternators. Non-salient pole rotors are used and ventilating fans are carried on flanges bolted to the rotor-winding retaining rings. Air coolers in which sea water circulates are mounted in a chamber below the stator frame.

The double unit propeller motors are rated at 42 500 hp maximum. Each consists of two machines, completely separate electrically, built into one casing. They are 42 pole, three-phase machines with salient pole rotors. Squirrel cage windings in the pole shoes provide induction starting and reversing. Each machine has a closed air circuit with electrically driven fans and sea-water circulated coolers mounted on top of the stator frame.

When each turbo-alternator is independently supplying its associated propeller motor, their ratings are 32·2 MVA, 3 087 rev/min, 51·5 c/s, 6 kV, 1·0 pf. When one alternator is supplying both propeller motors at 40 000 shp maximum, its rating becomes 30·7 MVA, 2 400 rev/min, 40 c/s, 4·670 kV, 1·0 pf.

Excitation for both alternators and propeller motors is obtained from two exciters, selected from four available in the engine compartment. Each of these exciters is driven in tandem with one of the turbo-alternators (1·5 MW each) serving the ship's auxiliaries. The four exciters are each rated at 300 kW normal, 300 V, 1 200 rev/min. Each has a closed air circuit (excluding the commutator) with a sea-water circulated air cooler mounted on the motor baseplate. The commutators are of Pollock construction, that is, the copper segments are supported along their entire length. Both port and starboard drives have automatic excitation control by 'Magnestat' regulators.

Vibration Analysis by Digital Computer

From the main propulsion motors the 30 in (76 cm) diameter propeller shafts extend out through hull bosses to the four-bladed propellers. The shafts run in white metal bearings, with oil seals at each end of the A-bracket and hull-bossing bearings. Careful analysis of the several modes of vibration that might be expected were made, including all shaft modes and possible propeller-excited resonances in the A-brackets. Much of this analysis was carried out on the digital computer of the Heavy Plant Division of A E I Ltd, Rugby. Wherever possible, impedances of the various elements of the dynamic system, comprising shafts, propellers, motors, and alternators, were checked by static tests.

The use of voltages as high as 6 kV is a new departure in merchant vessels and the cable installation presented certain problems. For the three-phase circuits, the suppliers, Johnson and Phillips Ltd, have estimated that two single-wire cables in parallel will be required for each phase of the half-motors. Thus two runs of cable, each containing four three-phase groups, will be required to couple the alternators to the motors. However, as the alternators are to be connected in various ways to the propulsion motors, a total of 8 three-phase groups

becomes necessary, making a total of 24 cables in this particular run.

Engine Control

The control console for the propulsion machinery is shown in the illustration; it has been built by the A E I Heavy Plant Division. In the centre of the console, two sets of levers control port and starboard machinery. Each set consists of 'direction', 'speed', and 'starting' levers, the 'starting' being the innermost levers. A telegraph reply actuator is mounted on the desks at each side of the levers.

Console instruments give detailed information about propulsion and excitation circuits, as well as speeds of turbines and propellers and the relative positions of the propellers. This last information is derived from a differential selsyn fitted to the propeller shafts. The cubicle below the console contains excitation switchgear for connecting the propulsion exciters for use. Excitation of the alternator and motor fields is under the control of the 'starting' levers.

A feature of engine room control reminiscent of nuclear power station practice is the provision of closed circuit television. It will enable the chief engineer to look at all important gauges and instruments in each of the machinery compartments. Also, by pressing a knob, he can scan each compartment with the remote camera. This is a particularly valuable feature during fog, when all watertight doors must be closed correctly and passage through all of the machinery compartments takes a considerable amount of time in so large a ship. The closed circuit television allows much faster inspection.

Bow Docking Propeller

A small propeller situated in an athwartships tunnel in the bow of the ship will provide a variable side thrust to assist in manœuvring the ship where tug facilities are limited. The Pilgrim bow propeller fitted in the *Canberra* provides a side thrust variable between two and nine tons in either direction.

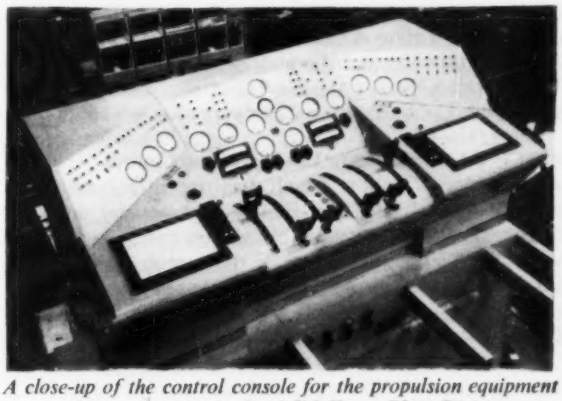
Electrical Services

Canberra is the largest ship to be fitted with an alternating current system for ship services. 6 MW of installed capacity is available for this use, quite separate from the propulsion generators. Following normal marine practice, a 60 c/s system is used. The installation of the a c system has enabled the adoption of loads that would, in a d c system, involve considerable complications in design.

The turbo-alternators for this supply were also produced by the Heavy Plant Division of AEI. Four geared pass-out sets, each with a combined condenser, are installed. Each is rated at 1·5 MW, 440 V, three-phase, 600/1 200 rev/min; steam conditions at the turbine inlet are 700 lb/in^2 (49·2 kg/cm^2) and 930 deg F (500 deg C); pass-out pressure is 70 lb/in^2 (4·92 kg/cm^2); steam quantity 15 000 lb/hr (6 800 kg/hr). A closed air circuit, sea-water circulated, cools each alternator. 'Magnestat' voltage control is used. Exciters for the alternators and for the propulsion main exciter units are V-rope driven from the propulsion main exciter, which is tandem driven from the alternators.

About 48 English Electric transformers will be used in the distribution system. These will be 440/250 V single-phase types, and will be designed for both 60 c/s and 50 c/s operation. In this way the distribution system can incorporate shore-to-ship circuits of different frequencies. Two standby diesel generators are installed for emergency use. Paxman 12-cylinder air-cooled Vega engines will drive G E C alternators rated at 200 kW.

Among the equipment served by the electrical system



A close-up of the control console for the propulsion equipment under construction in the A E I Heavy Plant Division

are the cargo transporters. There are three holds, totalling 150 000 ft^3 (4 250 m^3), at the fore end of the ship. The foremost of these will be loaded through a deck hatch by means of a travelling crane; but the other two will be loaded by specially designed transporters operating through the ship's side. They will handle every kind of load, from passengers' luggage to motor cars.

The transporter consists of a boom (housed on rollers within the ship) on which moves a carriage accommodating hoisting and traversing mechanisms, and operated from a cab attached to the same carriage. The overhead current collection equipment for the transporter was supplied by British Insulated Callender's Cables Ltd. Steps are taken to ensure that all current carrying parts of the conductor system are adequately insulated and that the bare conductors are completely enclosed. To do this, an extruded rubber compound (PCP) is used as a protective guard over conductors, and insulated shrouds are fitted over exposed metal fittings which support contact wires.

Two sets of stabilising fins of the Denny Brown type are fitted. Four 30 hp and two 5 hp motors have been supplied by W H Allen Sons and Company Ltd for this equipment. The fins are fitted in pairs, port and starboard, and retract into the hull when not in use. Control of their angle of incidence during operation, and hence their righting moment, is obtained by reference to small electrically-driven gyroscopes. Power for operating each fin is supplied by an electrically-driven variable output pump.

Air Conditioning

Air conditioning is an important provision for a ship operating in tropical waters. In the *Canberra* some 67 air conditioning units will be installed. It is estimated that refrigeration compressors will demand some 2 200 hp to meet a peak demand of 22·5 million Btu/hr (5·76 $\times$ 10^6 kg/cal).

A Power Station with Complete Remote Control

MANY unusual and interesting features are incorporated in the new power stations now coming into operation for the Central Electricity Generating Board. Among recent developments have been the semi-outdoor construction of the boiler units and the hydrogen-cooled generator at Willington A power station,* and the remote control system of station operation at South Denes.†

First C E G B Station to Use Electronic Control

Another new station which has recently been commissioned is Little Barford B, and several unusual features combine to make this station particularly noteworthy. Chief among them is the remote control and instrumentation system, which is based on electronic techniques and is the first of its kind to be used by the C E G B.

The first station on this site—Little Barford A—contains four 30 MW units and was completed in 1942. The second station—Little Barford B—was planned to double the capacity at the site by the installation of two 60 MW units, and these were recently commissioned.

The station has been designed for coal firing and the layout follows conventional lines. There are, however, several unusual design features which give special interest to this station.

The boiler house is an outdoor construction on similar lines to that of the Willington A station described in our last issue. The boilers are entirely exposed except for the milling and ash handling equipments which are installed in an enclosed basement. This feature results in a marked saving in construction costs, and further economies in the costs of the foundations have been effected by the use of turbines of the recently developed two-cylinder type.

Dust Extraction by Air Suction

Two other notable features are the main circulating water system, which has been so designed that each turbogenerator operates as a self-contained unit with its own cooling tower, and the method of air and dust extraction from the boiler ash hoppers, air heaters and precipitators, which is entirely by air suction without water sluicing.

The former arrangement has made it possible to omit valves in the main circulating water lines. The water end of each condenser is divided into two sections, each fed by a variable-pitch propeller pump. The suction pit is common to both pumps but the discharges remain separate up to the irrigation level in the individual cooling towers. The remote control system described in detail below is designed to maintain optimum efficiency by matching the pump output to the value of the condenser vacuum.

The two unit boilers are single-drum units with eight pulverised fuel burners in the front walls, designed for a continuous maximum rating of 550 000 lb (250 000 kg) an hour at a pressure of 950 lb/in² (59·8 kg/cm²) and a temperature of 910 deg F (488 deg C) at the superheater outlet.

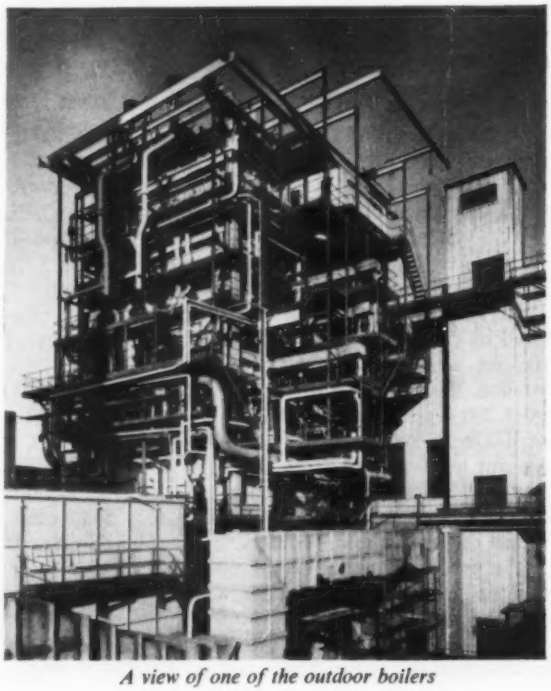
Control of the steam temperature over a load range from 80 to 100 per cent of the continuous maximum rating is effected by a hollow tube surface condenser which is used to alter the wetness fraction of the saturated steam entering the primary superheater. The air heaters are of the tubular type. Control of the induced draught fan is effected by a hydraulic coupling; but control of the forced draught fan is by moveable vanes in the fan itself.

The two turboalternators are Parsons 60 MW units of the two-cylinder impulse reaction type, and as the station uses cooling towers the back pressure has been taken at 1·3 in (33 mm) Hg. Feed water is heated to 385 deg F (196 deg C) by five-stage steam extraction. The alternators are hydrogen-cooled at a pressure of 15 lb/in² (1·055 kg/cm²). The generation voltage is 11·8 kV which is stepped up to 132 kV by the generator transformers.

Details of the Instrumentation System

The outstanding feature of the station, as already mentioned, is the electronic instrumentation and control system which was carried out by Evershed and Vignoles Ltd.

Briefly, the system is designed to give automatic control of boiler combustion conditions to match the steam demand, and it is based on the use of transmitters which measure such parameters as steam pressure and temperature, and water and steam flow, and simple analogue computers and three-term controllers which

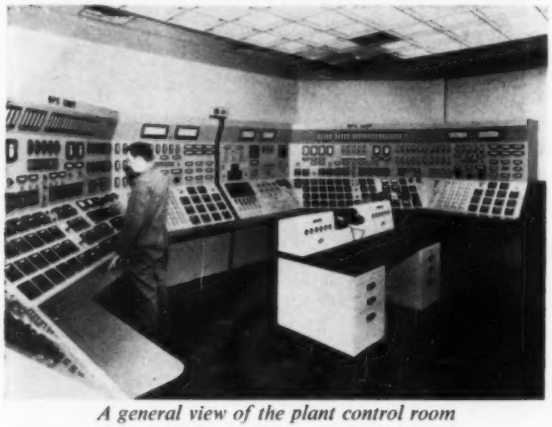


A view of one of the outdoor boilers

* THE BEAMA JOURNAL, **66**, No 4 p 123

† THE BEAMA JOURNAL, **65**, No 4, p 158

issue the necessary output signals to operate valve and damper positioners and so control the rate of fuel input, mill inlet suction, mill outlet mixture temperature, combustion chamber pressure, air/steam flow ratio, and steam temperature.



A general view of the plant control room

Specially designed transmitters located at the actual sampling points measure the required physical quantities and convert them into small proportional electric currents which are then transmitted to the plant operating room by telephone-type cable. Another advantage of this system is that it excludes all water, steam and ether fluids from the control room.

Electronic Repeater Principle

The transmitters operate on the principle of the Evershed electronic repeater, in which the current through a feed-back coil is adjusted until the force produced in association with a permanent magnet is equal to that caused by the physical quantity to be measured. These two forces are applied to a pivoted beam so that any out-of-balance force is made to operate contacts which vary the grid voltage and anode current of a thermionic valve, and thus the current in the feed-back coil, until balance is restored. Once set correctly, the relationship between output current and the measured condition is maintained and is independent of changes in supply voltage or frequency, output circuit resistance or valve characteristics.

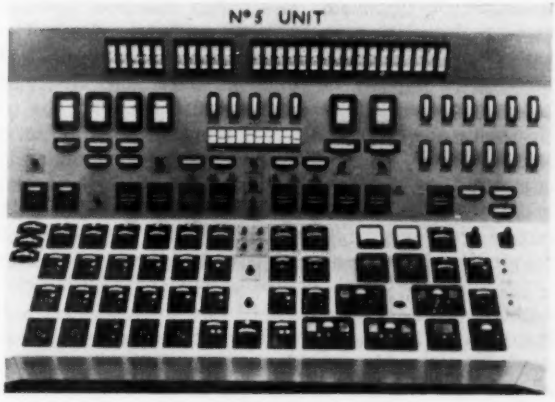
In several cases the signals from a number of transmitters are fed to a beam-balance type of computer, the output of which will follow a predetermined law. A particular example is the computer which controls the hydraulic coupling regulating the output of the id fan. This computer receives one signal which is proportional to the total fuel input to the mills, and another signal which is proportional to the boiler combustion chamber pressure. The output current of the computer is applied to the magnet of an oil-jet hydraulic actuator and converted to an operating force which applies the required correction to the id fan drive.

Three-term Electronic Controllers

The three-term electronic controllers previously mentioned compare the signal from the transmitter with a pre-set value and issue a three-term output proportional to the error or deviation, plus the integral and derivative of the error, the three terms being interdependent. This output is then used to apply the required adjustment to the positioners of the valves or dampers concerned.

These controllers are mounted on the panels in the control room shown in the illustrations on this page, and they incorporate the proportional, integral and derivative settings, the measured value and controller output currents, the desired value and hand-control settings, and an auto/manual changeover switch. An in-line scanner gives a ready visual indication of any departure from normal operating conditions.

Generator switching for the two units of the B station is housed in a separate control room outside the main building of the A station. The sets are operated on the unit system, each set having its own unit transformer. Station supplies at 3·3 kV are derived from one station transformer, with a standby interconnector from the 3·3 kV switchgear on the A station.



A close-up view of part of the No 5 unit control panel

Main Equipment Supplies

Among the main contractors were Evershed & Vignoles Ltd (Instrumentation and Electronic Control System); C A Parsons & Co Ltd (Turbo-Alternators, Generator Transformers, Condensing & Feed Heating Plant); Stewarts & Lloyds Ltd (High and Low Pressure Pipework); Bryce Electric Construction Co (Auxiliary Transformers and Station Transformer); English Electric Co Ltd (3·3 kV and 415 V Switchgear); A Reyrolle & Co Ltd (132 kV Switchgear); W T Glover & Co Ltd (132 kV cables); Chloride Batteries Ltd (Station Batteries and charging equipment); Mather & Platt Ltd (Fire Fighting Installation).

The Ninth Electrical Engineers' Exhibition

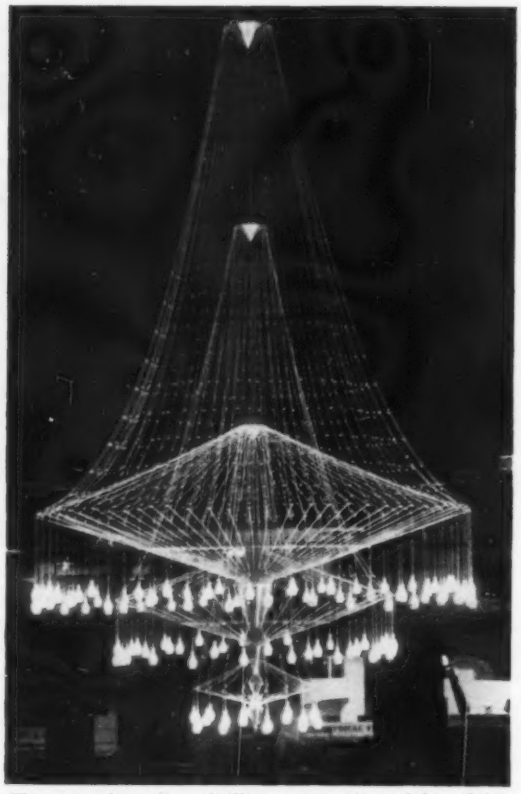
THIS year's Electrical Engineers' Exhibition organised by the Association of Supervising Electrical Engineers (A S E E) at Earls Court, London, outstripped all its predecessors in scope and size. It occupied 450 000 square feet (41 800m²); housed over 450 exhibitors, and electrical equipment worth more than £3 million was displayed. B E A M A member-firms comprised 40 per cent of the total number of exhibitors and accounted for something like 70 per cent of the stand space.

The exhibits revealed a widespread consolidation of technical development, with effort directed towards making electricity even easier to use and control. The feature of the show—the marine exhibit—exemplified this trend; a ship is a self-contained power generating and consuming unit, and ease of control and application of electricity are paramount requirements. However, the same design philosophy extended throughout the domestic and industrial exhibits as well: from the miniature circuit breakers replacing the domestic fuse box to remote-controlled power stations. A selection of the great variety of exhibits is described below.

Lighting

For artificial lighting, electricity reigns supreme. Fittings on show gave evidence of further efforts to improve ease of maintenance and interchangeability. A device produced by the Simplex Electric Co Ltd allows instant connection to or disconnection from a conduit system of a lighting unit, without disturbance of wiring or removal of the lamp. The device, called 'Discon', thus allows maintenance and cleaning to be carried out at a greater speed and consequently at a lower cost. The unit is in two parts: a socket portion attached to the conduit system by way of a standard circular box, after mains connections have been made to the terminals provided; and a plug portion, with heat-resisting cable tails and 0·75 in (19 mm) conduit male thread which is screwed into the reflector top after connections have been made to the lampholder. Although designed primarily for Simplex 'Arvit' reflectors of the dispersive and parabolic angle types, 'Discon' may also be used with any fitting that is tapped 0·75 in (19 mm) conduit on top. The fitting, with the lamp in position if desired, becomes a self-contained plug-in unit.

The unit is made for a c supply only, the plug contacts being silver plated and of adequate area to carry 15 A. It is dustproof and weatherproof and is held securely in position by a locknut. It is put into circuit by inserting the plug into the socket portion and turning clockwise.



This great electrolier—brilliant centre-piece of the exhibition—is believed to be the largest ever constructed anywhere in the world. (Details are give on page 53). It was not only an exhibition model, but a commercial product offered for sale. ('Electrical Review' photo)

Made in one size only, it is suitable for all commonly used sizes of reflectors, from 100 to 1 500 W.

Victor Products (Wallsend) Ltd showed a new miniature fluorescent fitting, suitable for 12 in (30·5 cm) 8 W fluorescent lamps.*

Other new products of the same company are weather- and vapour-proof 200 W lighting fittings for dangerous areas. One type of fitting—a single bolt lampglass housing—has three small wedge-shaped ramps in its top casting which mate with similar ramps on the lampglass housing. These are engaged and fully tightened by simply tightening up the draw-swing bolt. The other fitting—a toggle action lampglass housing—has a simple yet effective toggle mechanism whereby maximum pressure is achieved which, with the resilience of the lampglass gasket, gives a fully vapour-proof sealing.

To combat 'lighting fatigue' experienced through living and working under 'static' artificial light, the Radio and Electronics Division of A E I (Woolwich) Ltd have introduced 'Vitalite'. This converts the steady light of a fluorescent tube into a slow and continual variation in intensity. To produce this effect a reflector is mounted below the tube and slowly rotated by a small motor.

Streetlighting lamps that are also suitable for floodlighting and lighting large areas such as factory yards were shown by the General Electric Co Ltd. They were

* THE BEAMA JOURNAL, **67**, No. 1, p 37

200 W sodium lamps and the company claimed them to be of 25 per cent higher efficiency than other types of sodium lamp. A dimpled arc tube is used, which limits sodium migration and ensures uniform tube brightness along the lamp.

The centre piece of the whole exhibition was a giant electrolier. Suspended from the 100 ft (30·5 m) high roof of the exhibition hall, the electrolier itself measured 52 ft (15·9 m) high by 28 ft 6 in (8·7 m) maximum diameter. It was specially made by William McGeoch and Co Ltd and contained 126 Philips lamps of 100 W; 1¾ miles (2 820 m) of plastic covered cable, and 3 309 nickel-plated balls were used in its construction.

Electric Motors

The ubiquitous electric motor was much in evidence at the exhibition. Apart from improved ranges of standard models—more compact, economical and easier to maintain—there was shown a variety of types adapted for special duties and environments.

A new motor designed for the new narrow spinning frames coming into use in the textile industry was shown by the English Electric Co Ltd. The ring spinning frame motor (as it is called) is long and slim, with a low centre height. Motors in this range also have a special lint-free cowl instead of the usual air intake grids. At present the motor is available with 15 and 20 h p outputs. Also exhibited was a transformer cooling-oil pump motor, the pressure-tested steel frame of which bolts directly on to the pump casing and forms part of the oil system. Outputs up to 6 h p are available, at two-, four-, and six-pole speeds.

New totally enclosed fan-cooled motors for gas and chemical industries were exhibited as well. These were class E insulation types with outputs from 0·5 to 50 h p, and were treated internally and externally against corrosion. Other untreated versions were available for wide industrial use.

To meet a special mining requirement for a motor producing an output of 75 h p with a frame size restricted to 1 ft (30·5 cm) square, Newman Industries Ltd turned to water cooling. A totally enclosed stator assembly is fitted with a water jacket capable of operating pressures up to 500 lb/in² (35 kg/cm²). With a water flow of 5 gal (23 l) a minute, a change of winding resistance occurs that indicates a temperature rise of less than 55 deg C. While this is within class A limits, the insulation used is class B. The motor speed is 1 450 rev/min. To guard against coolant failure a thermostat is incorporated in the windings and may be used to operate an external control circuit. If water cooling were not used, a 2 ft (71 cm) square frame size would be required.

Another special requirement met by the company was for an induction motor to drive the belt of a Van der Graf high-voltage generator. The motor in this case is inverted: the inner member is stationary and the outer member rotates, its slightly cambered surface driving the belt directly. The four-pole, three-phase squirrel-cage machine develops 10 h p at 1 460 rev/min. An important requirement in the design was to keep the insulation resistance between the pulley and the spindle high; it is of the order of 20 megohms. The temperature of the class B insulation is less than 75 deg C under full load and normal atmospheric conditions. When installed in the generator, however, the motor operates in pressurised gas and the more efficient cooling that results decreases the temperature rise of the windings considerably.

Developments in class C insulation materials capable of operating at 600 deg C were displayed by Brush Electrical Engineering Co Ltd. This firm are investigating the possibilities of making special bearings to enable motors to operate at such temperatures, with a view to their application in the steel and nuclear industries where until now it has not been possible to provide direct forms of driving power.

The application of class C insulation to transformers was also displayed, indicating the possibility of producing transformers able to operate continuously at temperatures as high as 500 deg C.

A further extension of the range of environments in which electrical equipment can be operated was displayed by a motor running totally submerged in water. The insulation system was capable of withstanding complete immersion and, with further development, water can be used as the lubricating agent for the bearings.

Motor Control

As well as the wide range of motors displayed, there was also a noticeable increase in the variety of control equipment available for them. Laurence, Scott and Electromotors Ltd were showing their 'Asmag' speed regulation equipment as applied to non-synchronous motors. Typical applications include the control of pressure, level, thickness, torque, tension, voltage control of frequency changers, etc. The equipment shown gave an accuracy of ±0·25 per cent referred to top speed, with short term accuracies of ±0·1 per cent. Speed control signals obtained from a tachogenerator driven by the n s motor are compared with the setting of the speed-control potentiometer. The error voltage read off is fed into a push-pull magnetic amplifier whose power output stage feeds a low-inertia pilot motor. This drives an induction regulator through gearing. A transistor-stabilised reference supply is used for the control voltage.

To provide high accuracies over long periods of time, digital speed control equipment is available for use with the 'Asmag' system. This corrects any drift from the set speed which might arise during prolonged running, as a result for example of brush wear or similar causes.

Variable speed drives using magnetic amplifier controllers and d c motors were displayed by Lancashire Dynamo Nevlin Ltd. At present the company are producing three-phase units with outputs up to 50 h p, but it is likely that 100 h p units will be available in the near future. For single-phase operation, units with outputs between 0·25 and 3 h p are available.

The magnetic amplifier controller comprises a single or three-phase auto-self-saturating transductor fed from the a c supply, which feeds in turn a semi-conducting rectifier providing current for the armature of the d c motor. A separate single-phase rectifier provides the motor shunt field. Control of the level of the d c voltage fed to the armature is determined by the setting of a hand-operated potentiometer. Any difference between the reference voltage of the potentiometer and the armature voltage of the variable speed d c motor is

detected by the magnetic amplifier, which corrects the error. Silicon rectifiers are used to provide the power for the larger motors, and each controller is fitted with an a c airbreak contactor-starter and thermal overload unit.

A speed control system for d c motors operating under constant torque conditions was demonstrated by Brush Electrical Engineering Co Ltd. Silicon controlled rectifiers (p-n-p-n semiconductors, the solid-state device corresponding to a thyratron and marketed under the name 'Trinsistor' by Westinghouse Brake and Signal Co Ltd) of high efficiency make the system particularly attractive compared with the conventional Ward-Leonard set.

Armature voltage is varied by means of control of the 'firing angle' of the silicon rectifiers. Duplicate rectifiers in the reverse direction are employed for reverse operation of the motor and for regenerative braking. Accelerating or braking armature currents are automatically limited to the desired level by a current limit detector. The machine field is supplied by an auxiliary rectifier.

The control takes the form of a closed-loop servomechanism in which the speed signal from a tachogenerator is compared with a reference voltage. The error signal is fed to the transistorised control amplifier which controls a linear phase shift circuit supplying four pulse circuits that fire the controlled silicon rectifiers in a bi-phase rectifier-inverter power circuit. Speed can be controlled in two ways: manually by setting a potentiometer or automatically by, for example, punched tape. In the latter case the tape reading unit selects the required reference voltage according to the information punched on the tape.

Also shown by the company was static excitation equipment for automatic voltage control, using the Brush 'Retifex' system of control. The equipment provides full automatic excitation for a 2·7 MW, unity power factor, 6·6 kV, 50 c/s alternator being manufactured for the Liverpool Corporation. As such it is the largest static excitation equipment built by Brush to date and illustrates the potential application of transistor and magnetic amplifier techniques to the control of large rotating machines.

A motor with its own built-in motor coupling drive, to meet a variety of variable speed requirements in the power range up to 2 h p, was exhibited by Heenan and Froude Ltd. Known as the 'Dynamatic Adjusto-Speed', it is a combination of a quill-mounted squirrel cage motor and an air-cooled eddy-current coupling. The two are mounted in a common housing and a small built-in tacho-generator provides an output for external control circuits. Different types of control unit are available for applications requiring various drive characteristics.

Rectifier Equipment

Coadjuvant to many present-day motor control installations is large d c rectifier equipment. Many examples were shown at the exhibition, including rectifier cubicles for ship use—to convert shore supplies to ship services which, in spite of the new trend towards a c distribution, are still chiefly d c.

Silicon rectifier equipment was displayed by Lancashire Dynamo Nevelin Ltd for powers up to 750 kW. Each set of rectifier equipment comprises the necessary number of silicon cells connected in series and parallel to a number of different circuit arrangements, according to output requirements. Maximum efficiency is over 97 per cent, and this is maintained down to 20 per cent of full-load current. When cells are employed in parallel, paralleling reactors are fitted to ensure equal sharing of current. Each leg of cells is protected by a rapid acting H R C fuse which is selected to ensure that, in the event of a short circuit occurring on the d c system, the fuse clears before damage is sustained by any of the cells.

In the case of larger equipments feeding a number of sub-circuits, leg fuses may also be selected to provide discrimination over any feeder fuse. When cells are connected in series, voltage-dividing resistors are used to share transient inverse voltages equally across each diode. In addition, a surge protection circuit is fitted across the transformer secondary to limit stray transient voltage surges to a safe figure.

The English Electric Co also showed silicon rectifier equipment for heavy industrial and traction applications, for example for excitation supply of 1 100 kW, 540 V for a 120 MW alternator; supply for 1 000 h p traction motors on multi-unit electric trains, and for industrial and dockyard installations from 92 kW to 1 500 kW.

500 kW silicon rectifier equipment for applications such as dockyard, shore and shore-to-ship d c supplies was exhibited by Standard Telephones and Cables Ltd. Also shown were electroplating equipment using selenium rectifiers and producing up to 1 000 A at 8 V (with 63-step control of output voltage), and a constant voltage charger to C E G B specification T D C 76, class C; this unit will float-charge 24 lead-acid cells with a closely controlled and smoothed current.

A transformer and germanium rectifier built up together to form a complete unit was shown by the Electric Construction Co. Ltd. Natural cooling is used for the germanium rectifier, its output being 220 V at 102 A from a three-phase 400/450 V 50 c/s supply. The main step-down transformer is of the oil-immersed, naturally-cooled, double-wound type; the germanium cells are hermetically sealed and mounted on extruded aluminium fins. A new introduction by the firm is the addition of moulded case circuit-breakers to the input and output of the equipment. H R C fuses are provided for the protection of the germanium cells.

Switchgear

One of the most imposing exhibits in the exhibition was one phase and the operating mechanism of a 330 kV lenticular tank oil circuit-breaker, such as is to be supplied by A E I Ltd for the Kariba hydroelectric scheme. At the other end of the size range was a wide variety of switchboards, contactors, fusegear, relays, and domestic switches.

A 'packaged' sub-station incorporating a 500 kVA dry-type transformer, an 800 A circuit breaker, a sub-station fuseboard, and a 1 200 A fuse and isolator cubicle was shown by the Fusegear Division of the English Electric Co Ltd. The company consider that considerable savings in installation and running costs can be achieved by the use of the indoor packaged sub-station instead of conventional equipment outside

a production area. Units of this type can be installed at a load centre to feed out radially to individual loads.

The advantages to be gained from grouping together all the starters for the motors of a complete process line or section of a factory were emphasised by Laurence, Scott and Electromotors Ltd. Supervision and maintenance are facilitated, cabling and installation costs are frequently reduced, and by suitable design of the equipment much space can be saved. L S E drawout equipment for this purpose was exhibited. The draw-out principle enables a drawer (containing the actual motor starting and protection equipment) to be isolated from the busbars and drawn out for inspection merely by releasing one handle.

A new flameproof distribution board for the oil and chemical industries was shown by Siemens-Schuckert (Great Britain) Ltd. The board comprises three busbar chambers carrying at the top and bottom six 50 A contactors for motor control with on-off buttons on each enclosure, and an isolating switch fitted between the busbars and each contactor. The position of the outlet is quite flexible and the contactors can be replaced by flameproof air-break circuit-breakers.

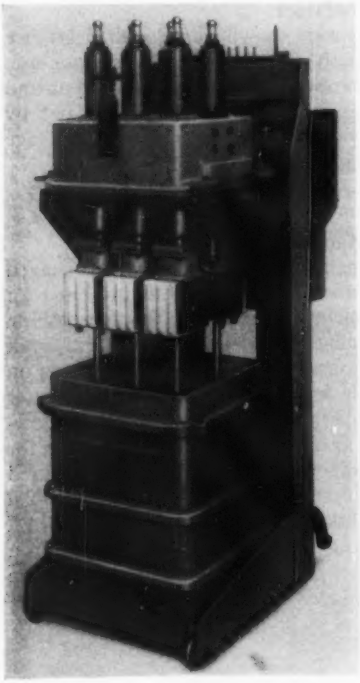
George Ellison Ltd showed a new range of 550 V heavy duty a c switchgear complying with BS 3185 : 1959 and having busbar copperwork complying with BS 159 : 1957. Various interchangeable switches up to 600 A are available, with a common mechanism used throughout the range. Each switch closes fully on fault regardless of the speed at which the handle is operated, and cannot blow open under fault conditions. The finger contact design is used throughout the range, the variation being on the number of fingers used per contact. Silver plated copper is employed for the contacts.

The new SX oil switch exhibited by Johnson and Phillips Ltd is designed for switching a ring-main or spur-feeder cable, or to provide a safe means of isolating and earthing sections of cable and connected equipment such as transformers. It is fitted with a manual spring-operated mechanism that removes dangers arising from hesitant closing.

The SX oil switch has the same rating as the new type P D B arc-control oil-circuit breaker, available in current ratings of 400 A, 800 A, and 1 200 A and providing 350 MVA safety for 250 MVA at 11 kV duty. Both units have recently been tested and certified at the K E M A testing station in Holland.

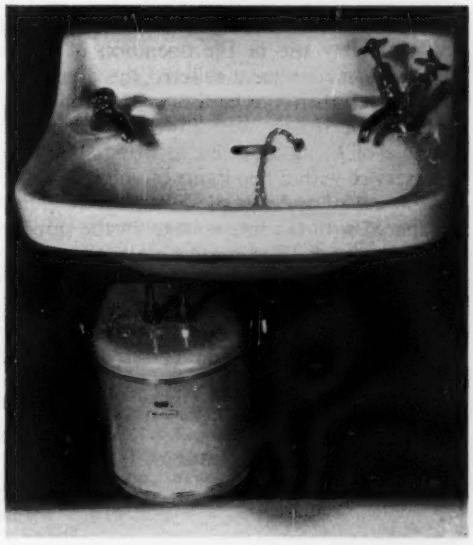
One of the switchboards supplied for H M Ships was shown by the Electric Construction Co Ltd. The contactors used were of the bar-mounted open type, all main poles being provided with easily renewable butt type contacts. In the case of the on-load contactors, the breaking pole is provided with electromagnetic blow-out and arcing shields. For extremely heavy duty the standard copper contacts may be replaced with silver tungsten. For circuits which remain energised for long periods without operation, fine silver contacts can be provided.

Switch-fuses about half the size of conventional industrial equipment were exhibited by the General Electric Co Ltd. 'Hidutac' switch-fuses, as they are called, are available in 15, 30, and 60 A, 440 V a c ratings, with either H R C or semi-enclosed rewirable fuses. The company claim the units to be capable of unlimited full-load switching—on the basis of 'exhaustive tests when carrying 1½ times full load current'. The switch-fuses will also break repeatedly eight times full load current at their maximum rated horsepower for D T L 440 V squirrel cage motors. To achieve this performance, cam-operated slow-break solid silver contacts are used, the switch element for each phase being individually enclosed to give maximum protection against flashover.



TWO OF THE AWARD WINNERS

Awards are made each year at the exhibition for outstanding electrical equipment among the exhibits. Highly commended in the Industrial Section was (left) *the type P D B oil circuit-breaker by Johnson and Phillips Ltd (details at top of this page). In the Domestic Section the silver plaque (the premier award) was won by Heatrae Ltd for their 'Lidomatic' hot water system. A model for installation under sinks and washbasins is shown on the right. The right hand capstan of the combination valve controls cold water through its own bib, and the left hand capstan controls cold water feed to the water heater. Hot water is discharged from the separate open bib on the left*



Fitted with a front-operated handle, the units have been designed to be suitable for situations where normal industrial gear would not be acceptable.

Front-handled switch-fuses were also among the new products displayed by the Midland Electric Manufacturing Company Ltd. These are produced in one-piece pressed steel cases—the 'Membrex-Exel' range, and fabricated cases of heavy gauge sheet steel—the 'Exel' range. The former are available in ratings up to 60 A, the latter up to 100 A, both at 500 V. The switch action is a self-contained unit that can be removed for inspection, and special handles are available to allow locking of the switch in the 'on' or 'off' position. A detachable switch bar is fitted, which on removal greatly facilitates speed of wiring.

Small Circuit-Breakers

On the stand of J A Crabtree and Co Ltd was shown a unit claimed to be the first all-insulated consumer's unit providing circuit-breaker protection. The unit has a silver-grey moulded cover enclosing a 60 A double-pole isolating switch and up to six miniature circuit-breakers which can be of various ratings from 2·5 to 50 A. The makers consider that the new circuit-breaker employed in this unit will offer a serious challenge to the rewirable and cartridge fuse on all types of installation.

A small circuit-breaker suitable for use in domestic consumer units was also shown by the M C B Company (Manchester) Ltd. The 'Lupus Midget', as it is called, is available for voltages up to 440 V a c and 125 V d c, with standard current ratings of 5, 10, 15, 20, 30, 50, and 60 A. Some 2 mV drop occurs across contacts for each 10 A flowing, the temperature rise being about 15 deg C at 30 A. A thermal-magnetic protective unit is employed which provides: a relatively long time-delay for small overloads by bimetal action; very short time-delay for serious overloads by magnetically assisted bi-metal action; instantaneous tripping on short circuit by electromagnetic action (this takes over completely beyond 10 to 12 times rated current).

Various transistorised monitoring relays for detecting mains failure, change in line voltage, or change in supply frequency, were shown by Brush Electrical Engineering Co Ltd. Conventional techniques depending on straightforward relay use or the operation of contact volt or frequency meters have suffered the disadvantage of the delicacy of their mechanisms. The transistorised mains failure unit shown was however a robust instrument capable of being adjusted to bring standby equipment into service within fine limits of voltage. This is achieved by the use of a Zener diode voltage reference which is compared with the line voltage on the three phases of a bridge network. The resulting error signal is amplified by a transistorised amplifier to operate a single relay. The voltage-sensitive and frequency-sensitive relays were similarly robust and used similar principles. Setting accuracies of 0·5 per cent of set value, or better, are claimed for each unit.

Miscellany

New Exide-Ironclad batteries suitable for standby supplies such as emergency lighting and communication equipment were displayed by Chloride Batteries Ltd. These batteries are now available with a multi-tubular 'gauntlet' of resin-impregnated Terylene cloth which is slipped over the spines of C B 95 alloy of the positive plate and holds the active material in a grip both firm and elastic. The gauntlet is extremely resistant to sulphuric acid and oxidation and enables the electrolyte to penetrate to the active material more freely than before, while reducing shedding of the active material to a minimum. At the bottom of the positive plate a Polythene moulding ensures that the gauntlet tubes are sealed. The negative plates are armoured with sleeves of Porvic to eliminate the possibility of internal short circuits and to enable the plates to meet the demands of increased output.

Planté cells recommended for trickle charging, floating, or conditions not requiring frequent cycles of discharge, were exhibited by Pritchett and Gold and E P S Co Ltd. The special feature was a saving of up to 50 per cent in space compared with standard stationary cells. Porvic microporous plastic separators have made it possible to reduce plate pitch without the likelihood of short circuits developing. This feature also reduces the internal resistance of the cell.

A mobile welding set with current control from 30 to 400 A was exhibited by the Transformer Division of A E I Ltd. Designated the D A 400 Paradyne, it consists of a single motor-generator set mounted on rubber-tyred wheels and fitted with a pram handle. The equipment is designed in accordance with BS 638 : 1954 Group X to give a maximum continuous hand welding rating of 300 A, 30 V, with a maximum intermittent welding rating of 400 A, 35 V. A 3-phase squirrel cage 2-pole motor is used, the d c generator having a dropping characteristic to reduce power loss during welding. An additional socket outlet provides an auxiliary supply of 25 V rated at 10 A. This is useful for operating a portable handlamp or electrode drying container.

The same company were showing an electric resistance rivet heater with three heads, for multiple operator use. It will heat rivets within seconds of being switched on and is capable of handling rivets from $\frac{3}{8}$ in by $1\frac{3}{4}$ in (9·5 by 44·5 mm) to $1\frac{1}{8}$ in by 4 in (26 by 102 mm) at an average rate of 195 lb/hr (88·5 kg/hr).

Testing Packaging Materials

Much of the equipment on display would be packaged for transport to customers. Ferranti Ltd exhibited an instrument suitable for measuring the cushioning properties of packaging materials. The portable peak accelerometer has two main units: a probe for fitting on the sample under test, and an indicator unit. The latter incorporates a cathode follower, an a c amplifier, a low-pass filter cutting off at 675 c/s, and an output socket for connection to a cathode ray oscilloscope. It is also fitted with a meter giving readings in *g* on four ranges 0-25, 0-100, 0-250, and 0-1 000. Minimum readable *g* is 3. A special feature of the instrument is that it can retain a reading to within 2 per cent for 30 sec even though the actual shock pulse may be as short as 1 millisec.

Notes

Refrigerators by Air to U S A
Nearly 370 refrigerators were recently flown from Prestwick Airport, in Scotland, to New York for immediate distribution in America. The load, which weighed some 14½ tons, was carried in a Super-Constellation of the K L M freighter fleet and was one of the heaviest loads ever to be flown across the Atlantic. As a result of the operation the refrigerators arrived in the consignee's premises within 48 hours of leaving the manufacturer's Scottish factory.

Behind this unusual shipment lies an interesting story. The refrigerators in question were Astral models made by Morphy-Richards Ltd, and a few years ago the company discovered that there was an extensive U S A fringe market for a small refrigerator designed to meet specialised 'on-the-spot' needs. This fringe market exists in the medical field, the catering business, offices, factories, and even homes for use in the living rooms. In addition, it is estimated that seven million Americans live permanently in caravans, known in the U S A as 'trailer homes'.

In recent years Morphy-Richards have exported ever-growing quantities of their Astral table model refrigerator to meet the demand from this important fringe market. Recently the company introduced, primarily for the U S A market, a new table model refrigerator of which there are two versions—one for operation on electricity, the other on bottled gas. Both versions were included in the air freight consignment.

Large Motors for Rhodesia
Lancashire Dynamo and Crypto Ltd, through their Central African company, have received an order for six 1 500 h p 11 kV water-cooled synchronous motors for driving main drainage pumps at the Bancroft Mine in Northern Rhodesia.

This is the first time that motors of this voltage have been used on any of the mines of the Anglo-American Corporation Group on the copper belt. Previously all motors have been wound either for 3·3 or 6·6 kV, but since the mains supply to the mine is at 11 kV this meant that they either had to transform to the lower voltage above ground and then have heavier cables going underground, or take the 11 kV underground and have the transformers in the mine—an arrangement which necessitated the excavation of underground transformer chambers.

By utilising 11 kV motors, the cost of transformers is eliminated completely, as well as the cost of the l t switchgear; smaller cables are utilised throughout.

Bancroft Mine has a pumping capacity of about 20 million gallons (91 mega l) of water a day—considerably more than the daily average of water required by Salisbury, the largest city in Central Africa.

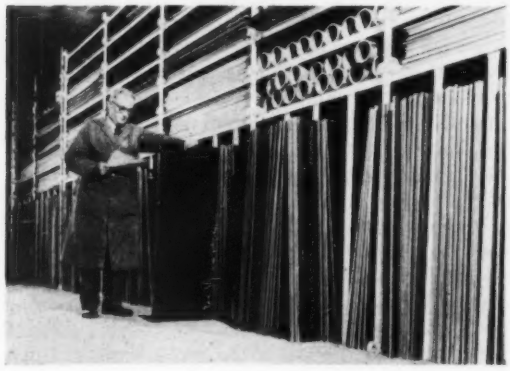
Motors for Seven Oil Refineries
Newman Industries Ltd, of Yate, Bristol, whose electric motors include specially developed ranges for use in hazardous locations, have received orders for explosion /flameproof and totally enclosed motors ranging from 7·5 to 200 h p for seven American-controlled oil refineries and chemical works in Mexico, Canada, Australia, Malaya and Thailand.

Newmans, who now have 21 district offices and 300 distributors in the United States, are the only British firm to have secured the approval of the official Underwriters' Laboratories Inc for a range of explosion-proof motors.

One contract is a 'blanket' order to supply all the electric motors in the explosion / flameproof range up to 125 h p for a major extension of the Petreolos Mexicanos Oil Refinery at Miniatitlan, Mexico. In addition, the Bristol firm will supply totally-enclosed motors ranging up to 200 h p for a new chemical plant attached to the refinery.

Construction of the refinery extension and chemical plant is by the Fluor Corporation which has also ordered both explosion / flameproof and totally enclosed motors from Newmans for a gas plant at Carstairs, Alberta.

Other contracts, all for totally enclosed motors and mainly in the 75 to 150 h p ranges, have been placed with the company for a new petro-chemical plant at Altona, near Melbourne, Australia; a refinery at Bangkok, Thailand; the Kurnell Oil Refinery at Sydney, Australia, and a refinery at Duri, Malaya.



A shot from the film 'Tufnol in the Making' recently produced for Tufnol Ltd of Birmingham by the Ellison Film Unit. The film shows the manufacture of Tufnol from the arrival at the factory of the paper, cotton and phenolic raw materials, through the impregnation and pressing to the finishing processes. Our picture shows some of the wide range of finished tubes and sheets in stock for immediate delivery to users all over the world. The film is a 16 mm colour film and runs for 24½ minutes

£2½ Million Spanish Contract
An order worth nearly £2½ million for hydroelectric generating plant for two new Spanish power stations has been won by the English Electric Co Ltd against strong European competition.

The machinery has been ordered by Hidroelectrica Espanola and will be installed at Valdecanas and at nearby Torrejon, both some 120 miles (193 km) south west of Madrid. The power stations are the first to be built on the Spanish section of the River Tagus, and the 108 000 h p pump-turbines at Valdecanas will be the most powerful in the world. The total output of the two stations will be 400 MW.

Valdecanas, which is the first stage of the development, will be a major pumped storage scheme and the second largest of its kind in Europe. The largest is the British scheme in North Wales, where English Electric are supplying four 105 000 h p water turbines.

Delivery of the equipment will start in 1961. Three 108 000 h p turbines and three 83 333 kVA alternators are being built for Valdecanas and four 36 000 kVA alternators for Torrejon. All this equipment will be built at English Electric's works near Liverpool. Associated 230 kV and 138 kV airblast switchgear for distributing the power from the stations will be made at the company's works at Stafford.

The three reversible Deriaz pump turbines operating on a head varying from 160 feet (48·7 m) up to nearly 250 feet (76·2 m) can each produce a maximum of 108 000 h p. The maximum pumping head will be 240 feet (73·2 m). The turbines will run at 150 rev /min and will be equipped with adjustable blades on the runner and adjustable vanes to control the machine load.

The turbines will be coupled to English Electric semi-umbrella type 83 333 kVA alternators. For their pumping duty the alternators are designed to operate with reverse rotation as motors and have a pivoted pad type thrust bearing. High pressure oil jacking will reduce the starting torque.

Magnetic amplifier static voltage regulators will control the excitation of the machines when operating either as generators or motors.

Consent for Seventh Nuclear Power Station
It is announced by the Central Electricity Generating Board that the Minister of Power has now given his consent to the building of a nuclear power station at Sizewell in Suffolk.

This will be the seventh nuclear station either sanctioned or under construction in Great Britain. Four stations are now being built in England and Wales for the C E G B; another is being built in Scotland for the South of Scotland Electricity Board, and consent has been give for a sixth station to be built at Dungeness, in Kent.

The outputs of these stations will range from 275 to 500 MW, but the new station at Sizewell will be larger than any of the others, with a planned output of 650 MW.

Tenders for the new station are being sought immediately from the consortia of companies specialising in the construction of nuclear power stations.

The Cologne Hardware Fair

THE thought of almost one million sq ft (93 000 m²) of exhibition space in one place at the same time is a matter for envy by the inhabitants of crowded Great Britain. This however is roughly the size of the Cologne exhibition halls—ten in number—which are fully booked for the International Household Goods and Hardware Fair in the spring and autumn of each year. Over 1 600 exhibitors from 18 or 19 countries were present at this year's Spring Fair, which was held from 11-14 March and attracted between 50 000 and 60 000 buyers from over 60 countries.

The exhibit organised jointly by the British Electrical & Allied Manufacturers' Association and the Board of Trade at the 1960 Spring Fair was an exploratory venture on a small scale, staged to sound the Continental market in this highly competitive field of household electrical appliances, against the background of trading conditions in the European Common Market. From this point of view the display was a success—demonstrating to buyers from Europe and many other parts of the world that the British domestic appliance industry has much to offer in quality, design and diversity of products.

Mr J A M Marjoribanks speaking at the Press Reception on the day before the opening. On his left is Mr Stanley F Steward, Director of the B E A M A

The combined British exhibit was in Hall I, which contained a complete cross-section of the appliances and general hardware available, with no particular type predominant. This diversity made the Hall the focal point of interest in the Fair. The position and small size of the British stand were disappointing, however, because the exhibit could not reflect the real size and standing of the British industry with its annual output of appliances worth more than £175 million. Nevertheless the stand was teeming with activity and was obviously creating considerable interest among buyers and other visitors.

This interest was reflected in press comments, which gave full marks to the British exhibitors for being the first to be ready for the opening, and for the variety of appliances on show in such a small space.

Particular interest was created by the automatic features of several new appliances on show on the Continent for the first time. Outstanding exhibits included a new automatic washing machine, an automatic clothes drier, and coal-effect fires which received special mention in many German newspapers. There was also much interest in the sink water-heaters, bathroom oil-filled radiators, the neat electric cookers and the floor cleaning machines on show. In fact, there seemed little doubt that the styling and general appearance of the major appliances on display were not only in line with Continental requirements but contributed a number of new ideas.

Exhibitors at the Fair for the first time were impressed by its international character, and some firms reported that more than half their enquiries came from outside Germany. Most of the latter came from European countries but considerable interest was also expressed by visitors from South America and the U S A.

B E A M A Director Urges a United Europe

A Press Reception was held on the combined British stand during the afternoon preceding the opening of the Fair, when visitors included Herr P P Ortmann of the Federal Parliament and also Deputy Chairman of the Fair Authority, and Mr J A M Marjoribanks, HM Minister (Economic) in Bonn. In his speech of welcome, Mr Stanley F Steward, Director of the BEAMA, referred to the significant developments in design and output of British domestic electrical appliances sold both at home and overseas. He compared development in Germany and the United Kingdom and expressed the view that the two countries could well complement and strengthen one another in their efforts to improve the lot of the housewife and the general standard of living throughout Europe. He said that the BEAMA was working actively to build a bridge between the Common Market and the Free Trade Area, since he felt strongly that there must be a united Europe and not two sharply divided sides pulling in different directions. The B E A M A's entry into this Fair for the first time was an earnest of this intention.

What of the Cologne Fair as a whole? From discussions with the Director of the Fair it appeared that demands for space far exceeded the capacity of the existing exhibition halls, and that even with one million sq ft available the Fair Authorities are having to do more building to cope with the demand.

It is probably true to say that every kind of household labour-saving device was on show at the Fair—sometimes in bewildering numbers. Here could be seen the latest trends in Continental design and the latest eye-catching features with which Fairs of this kind abound.

In the cooking department, one such feature was a particularly interesting little device which took the form of a new approach to the closed oven door. This was a prism set into the hob of a cooker in such a way that it acted as a reversed periscope to allow the housewife to view the cooking going on in the oven without opening the door at all. It was noticed, however, that the piece of food which was cooking was of the 'clean' variety in that

there was no spitting fat to mar the view; also the prism was placed in such a position that in order to obtain the best view of the food one might well need to brave the dangers of steam and other hazards peculiar to the top of a cooker when in use.

As one would expect in a Hardware Exhibition, there were large numbers of stands devoted to what can best be termed 'ironmongery', and the most noticeable feature of these stands was the wide use of colour in the presentation of the goods.

The general lay-out of the Fair was unquestionably excellent; the stands were well spaced, well sign-posted and well served. The press arrangements were in the same category, and the German capacity for thoroughness was everywhere evident.

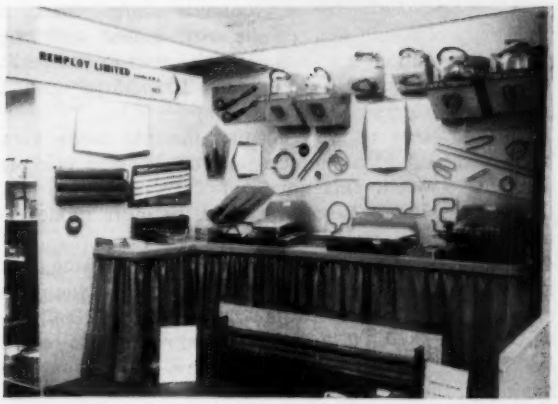
With these impressions in mind, a tour of the British exhibitors revealed that they were apparently very happy and doing what seemed to be very good business.

Remembering some of the magnificent stands and positions occupied in British exhibitions by many BEAMA member-firms, there is no doubt that if the BEAMA participates in the Cologne Fair in 1961 it must have a better and bigger position, so that the British domestic appliance industry can display its products in a way which will do full justice to the British contribution to the manifold uses of electricity in the modern home.

The British Section at Cologne

The accompanying photographs show some of the stands in the British Section at the International Household Goods and Hardware Fair in Cologne. The British exhibitors were as follows:

Columbus-Dixon Ltd.
Corfield-Sigg Ltd.
Dimplex Ltd.
Electrical Division of Radiation Ltd.
Electrix Ltd.
English Electric Co Ltd.
Hoover Ltd.
Remploy Ltd.
Revo Electric Co Ltd.
Simplex Electric Co Ltd.



The Refrigeration Market

R Craig Wood *

THERE can be few people connected with the domestic refrigeration business in the U K who have not shaken their heads in amazement at the dramatic change that has taken place in the market over the last three years.

1957 was the turning point in the fortunes of the industry. Until that time the domestic refrigerator had been a 'Cinderella' of the electrical appliance business; then, for the very first time, sales topped a quarter of a million and the manufacturers were caught without sufficient production to meet trade demands. Hurriedly they reviewed their production plans for 1958 and 1959, but it takes time to make big increases in factory capacity, and to their mixed feelings of delight and despair they have seen the market leap in 1959 to a total of 960 000 refrigerators, of which 120 000 were imported models.

No one can justly criticise the failure of refrigerator manufacturers to meet this sudden up-surge in consumer demand, which was caused by the cumulative effect of five factors operating sometimes alone, sometimes collectively, over the last three years.

First, the refrigerator business had been approaching what in marketing terms is called 'the threshold of consumer acceptance'. This is a point in the growth of a product when sufficient people own it and sufficient people know about it to make its sales start to snowball. This point is generally reached when 10 to 15 per cent of the potential users possess it.

Second, other major consumer durable needs were being satisfied. Most families buy a television receiver first, then a washing machine, and next a refrigerator. As the other two purchases are made, so more money is available for a refrigerator.

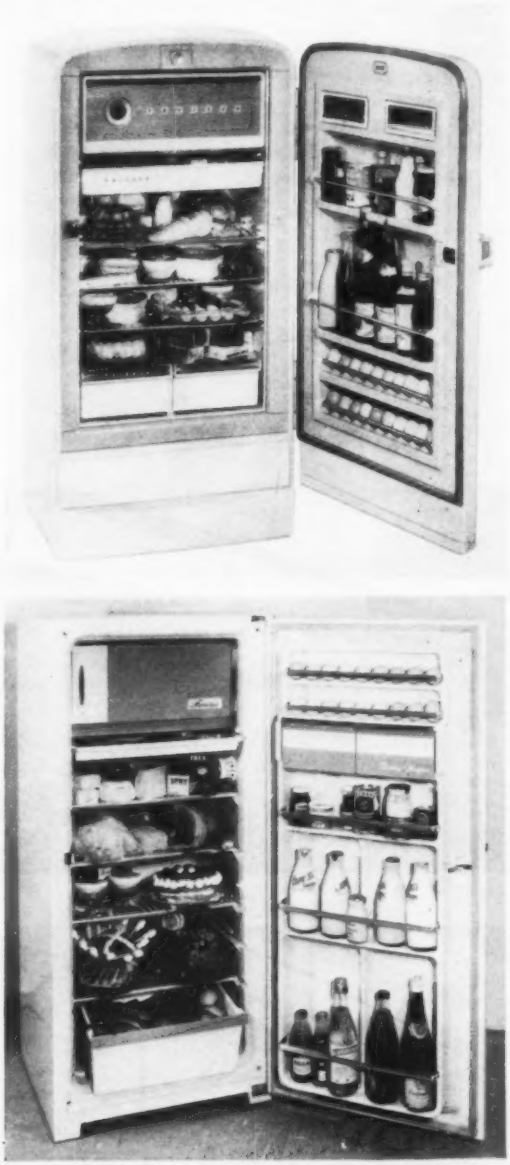
Third, refrigerator manufacturers were increasing their advertising expenditure. In 1957, advertising in the press and on commercial television amounted to £272 000; this was increased to £480 000 in 1958 and rose to the record figure of £713 000 in 1959. All this advertising was having the desired effect of stimulating consumer demand.

Fourth, the weather also played an important part. The summer of 1959 was almost one continuous heat-wave, and many people who had perhaps never before thought of owning a refrigerator were compelled to buy one in order to make life tolerable.

Perhaps the most important factor of all was the removal of hire-purchase restrictions in October, 1958. The previous reduction in purchase-tax naturally assisted sales, but it is a fact that many consumers are more concerned with the small amount of the initial payment rather than with the total purchase price.

These factors operating together have produced an almost explosive development of the refrigerator market. Increased sales volume, however, was not the only change that was taking place during this period.

The number of manufacturers had increased as well. In 1957 there were no more than twenty different makes



Two of the larger types of British refrigerators. (Top) *the 8 cu ft (0·5 m³) model by G E C and* (below) *the 9·4 cu ft (0·57 m³) English Electric 'Slimline Elite'. Note in each case the full width freezer locker and chiller tray, and capacious door storage. Push-button defrosting is another feature of this latest English Electric model*

* Managing Director, A E I-Hotpoint Ltd

on the market, but by the end of 1959 there were nearly seventy different makes available in the United Kingdom.

Distribution too was changing. The number and variety of outlets stocking refrigerators increased considerably; dealers were beginning to realise that refrigerators were being bought in the winter as well as in the summer and that if they wanted their share of the business, they had to show the models all the year round. The traditional peak summer-selling period was beginning to level out at last.

But what about the refrigerators themselves? The average capacity has been slowly increasing. Although it is still true that approximately 90 per cent of all refrigerators purchased have a capacity of under 5·5 cu ft (0·156 m^3), the fact remains that the most popular size is now of 3 to 4 cu ft (0·085 to 0·113 m^3), whereas a few years ago it was 1·5 to 2 cu ft (0·043 to 0·057 m^3).

More attention has also been paid to styling. There is now a distinct trend towards the squared-off line. This allows the refrigerator to take its part as an integral unit in the kitchen furniture instead of being a somewhat bulky and inharmonious mass. Flexibility now seems to be the keynote, and manufacturers are providing models with doors which open within the width of the cabinet and are available with optional right- or left-hand hanging.

Refrigerators generally are now far better equipped. Large freezers to accommodate the increased consumption of frozen foods; salad bins; interior lights; egg-racks and butter and cheese compartments are all becoming necessary features.

As far as the technical changes are concerned, there has been a greatly increased use of plastics; almost every refrigerator now has a plastic liner and one or two even have plastic cabinets. Great strides have been made in the development of refrigerator door latches, which have moved quickly from the trigger-type, through the 'glide-in' type, which needs only a slight pull to open it, to the very latest magnetic gaskets which require no latch at all.

Foamed insulation now promises us the miracle of putting 'two pints into a one-pint pot'. Most recently of all we have seen the possibility of thermo-electric refrigerators based on the direct conversion of electricity to 'cold'.

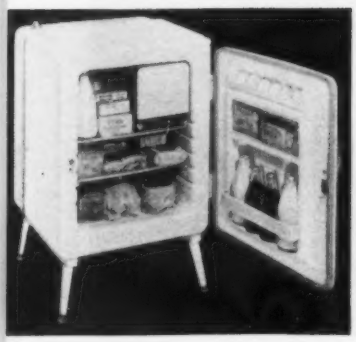
So much for the past and present; what of the future?

On the assumption that no drastic credit restrictions or crippling purchase tax are again imposed, we consider that consumer offtake will continue at something like last year's rate. It certainly will not increase at the rate it has over the last three years. On the other hand, as manufacturers increase their production, so the competition will become keener, and only the strong and efficient manufacturers will be able to survive.

As the market develops, so will replacement sales. These sales, which at present account for approximately 12 per cent of consumer offtake, can give manufacturers some indication of future market trends.

Refrigerator owners invariably want a larger refrigerator and are able to make a more critical appraisal of the models they consider buying: capacity, positioning of shelves, size of freezers, chiller tray and salad bin—features which they probably ignored or took for granted at their first purchase. The more sophisticated are beginning to look for automatic defrost and zero temperature storage compartments. We can expect to see all these features introduced during the next few years in bigger and better models, along with the technical improvements of thinner insulation and smaller compressors.

In brief, there seems to be a challenging and vigorously competitive future for domestic refrigerator manufacturers.



Five representative models of the smaller types of refrigerator. (Top left) *the Morphy-Richards 'Astral' of 2·3 cu ft (0·06 m^3);* (bottom left) *the Jackson all-plastic model of similar capacity.* (Centre) *the new Creda 3 cu ft (0·085 m^3) model notable for its full width freezer compartment;* (top right) *the Electrolux 2·6 cu ft (0·074 m^3) model;* (bottom right) *the new Hotpoint 3·7 cu ft (0·105 m^3) 'Iced Diamond'. This model is mounted on rollers for easy movement*

Vacuum Cleaners Began in Britain

Stanley Broughton, FCA *

EVEN when men lived in caves, someone—obviously mother—must at some time have considered the 'home' needed cleaning. One supposes that after disposing of a few bones left over from the Sunday joint and the broken flints left by father after a 'do it yourself' session, the prehistoric housewife's work was complete. The advent of the broom and, later, a form of dustpan marked a step forward towards solving the housewife's cleaning problem, and the introduction of the carpet sweeper was undoubtedly one of the greatest labour-saving developments of its time.

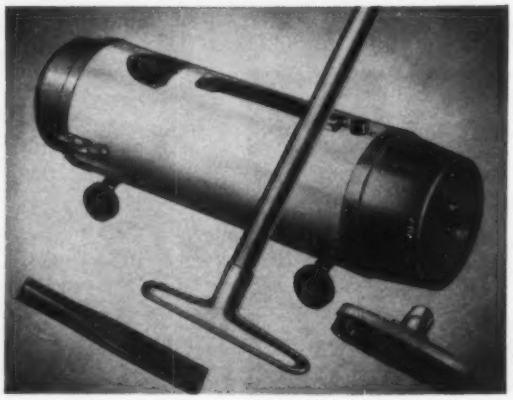
For domestic use, the first cleaners were operated manually with the aid of bellows. The cleaner we know today really owes its development to the invention of the electric motor. That in turn stems from the electromagnet first produced by the British scientist William Sturgeon in 1825, and subsequently developed by various other scientists and engineers until it became the basis for the development, not only of electric motors, but of dynamos, various telegraphic apparatus, and electric bells. The provision of electric current from supply stations which began in the early 1880's acted as a tremendous stimulus to the more rapid development of electric motors and their eventual manufacture in quantity for use in domestic appliances.

One day in 1901, four young civil engineers met for lunch in an Italian restaurant near Victoria Station, London, and one of them—John Jackman—invited two of the others—Cecil Booth and Charles Hitchins—to accompany him to St Pancras Station to watch a demonstration of cleaning. Arriving at St. Pancras, they watched a young American, Mr Thurmann, put his new 'dust machine' through its paces. Mr Thurmann's principle was a nozzle blowing a powerful jet of air on to the upholstered seat of a railway carriage. This was supposed to blow the dust from the upholstery into a box fitted near the nozzle. In practice, however, most of the dust was blown out of the carriage window. When Booth asked whether suction would be better, young Thurmann told him he had tried suction but it was useless.

On returning to his office, Booth decided to make an experiment himself. Wetting his handkerchief, he placed it on a carpet, lay down, breathed in hard through his mouth, and produced a ring of black dirt. He had made a suction principle work, and so began the history of the British Vacuum Cleaner Company, makers of the Goblin cleaner.

A little later Booth's 'Vacuum' appeared. It was drawn by two horses and operated by a powerful pump known as 'puffing Billy'. It became extremely popular, especially around the West End of London. Hoses were connected to the machine, led in through the doors of the most

(Left) *The beginning of the vacuum cleaner industry—Booth's original machine, now in the Science Museum in London.*(Right) *A very early hand-operated Goblin model.* (Below) *The latest Goblin cylinder type cleaner*



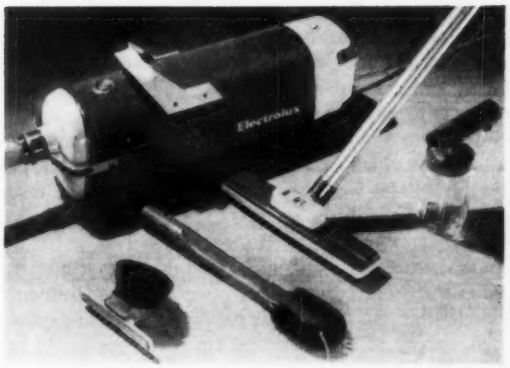
*Managing Director, Electrolux Ltd.

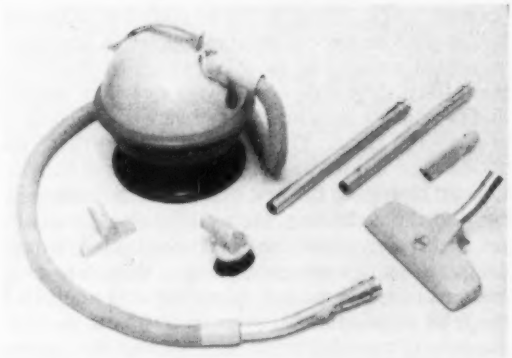
fashionable houses and vast quantities of dirt were removed. Ladies with a flair for the unusual used the occasion to organise 'vacuum cleaner tea parties' so that their friends could enjoy the entertainment. In 1907 came the 'Witch Dust Extractor'. Operated by two people, one of them had to tread on bellows to induce suction, while the other person held the hose and did the cleaning.

By 1914, when many of Booth's patents had expired, electrically operated domestic cleaners began to be manufactured on a wide scale. At first, many of the designs were based on the method used by their forerunners, the carpet sweeper. Bearing in mind the heavy furnishings of that period, home cleaning until the advent of the vacuum cleaner was a complicated and arduous task. It would therefore have been pleasant to record an immediate customer response; but from all accounts our mothers and grandmothers were slow to take advantage of the introduction of such a time and labour-saving appliance.

In 1915, in the latest issue of her mammoth book on household management, Mrs Beeton—the expert of all time—told us 'before sweeping rooms, strew the floors with dried tea leaves or freshly cut grass from a lawn. These will attract the dust and save much harm to the furniture, which should be covered during the process'. Perhaps Mrs Beeton was reflecting the times, for sales were very slow to increase.

Between the two world wars there was a marked trend towards the upright cleaner and of the total number of cleaners sold, the greater number were of this type.





A representative selection of British vacuum cleaners. (Top right) *The latest Electrolux.* (Centre right) *The new Hoover Constellation.* (Bottom right) *The Hotpoint Model 420.* (Centre top) *The Morphy-Richards Model* V B A (Centre bottom) *The Parnall Ten-ten.* (Extreme left) *The G E C upright model*

In the immediate post-war period, the ratio of upright cleaners to the number of cylinder cleaners sold began to even out and the public's preference began to follow the trend experienced in the USA. The popularity of the cylinder cleaner began to increase in Britain.

The late 1940's and early 1950's were beset by crisis after crisis. Steel supplies were short, so was fuel; production and sales were then influenced by a trade recession. By 1954 our troubles seemed to be over, for home sales in that year exceeded the million mark. But in 1955, when manufacturers were laying plans for expansion, further inflation caused the Government to re-introduce credit restrictions and to increase purchase tax, and demand fell.

A survey of the domestic electrical appliance market, published by the *Electrical Times*, showed the position in the mid 1950's. About 50 out of every 100 households in Britain used an electric vacuum cleaner. A breakdown of individual sections of the market showed that 72 out of every 100 middle class homes used a vacuum cleaner, but that in working class homes they were used in only 30 out of every 100 homes. This evidence suggests that while the middle class housewife—after 50 years—had accepted the vacuum cleaner as the best and the normal way of doing her household cleaning, the working class housewife had yet to be convinced that the conventional broom and duster was only a convenient way of removing dust from one part of her home and depositing it in another. From the sales point of view, when dealing with middle class customers, manufacturers had reached the position in which they had to concentrate on increasing the replacement rate—and thereby increase their number of new models. Among the working classes there was still great scope for increasing sales.

At that time just over half of all the vacuum cleaners in use were of the upright type, and the survey showed that this was preferred by six out of ten housewives over the age of 43. Cylinder type cleaners were used more frequently by the younger housewives. Present purchasers continue to show some preference for cylindrical models.

After 1956, home sales began to recover and have not looked back since. In 1959 they reached a record level of nearly 11 million. According to a survey prepared by the Economist Intelligence Unit Ltd in association with the British Market Research Bureau Ltd, the market saturation of vacuum cleaners is now about 66 per cent. The upper and middle class households continue to be the predominant users of the appliance, and there is still a need to sell the idea to working-class households. Ownership varies with locations. It is highest in London; lowest in Wales and the South-West.

Over 30 firms manufacture vacuum cleaners, but of these manufacturers not more than six could be described as being among the leaders in the field.

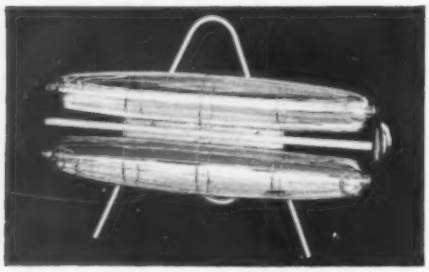
Improvements in design are continually being made and they follow the trend so evident with all domestic appliances—the trend towards easier operation. There is a far greater use of plastics; colour schemes—many in pastel shades—are becoming more attractive. Cleaners are becoming more versatile and far easier to handle, and there is a tendency to increase the versatility of the tools supplied with them and to reduce their number.

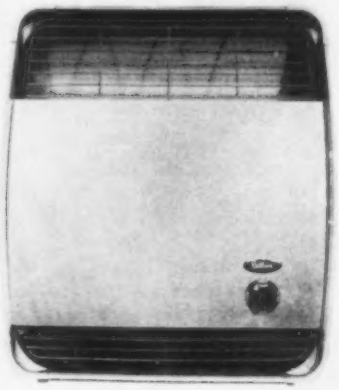
Exports of vacuum cleaners in recent years have been remarkably steady with an annual turnover of around £2 000 000. Considering the intensity of competition in this field, the results cannot be considered unsatisfactory. However, with the continuing tendency for manufacturers to start local production or assembly abroad, increased efforts will have to be exerted to improve these export figures.

As to the future, competition is likely to be very keen, and while the home market is capable of some limited expansion, the outlook on the replacement side is healthy. Many of the cleaners sold during the pre-war peak years are becoming due for renewal, and nowadays there is a marked tendency to buy a new model instead of one that is second-hand. The ingenuity of our designers is, and will always be, the factor which influences this tendency in the future.

THREE TYPICAL EXAMPLES OF HEATERS

(Left) *The handsome 'Wilton' coal-effect fire by Berry's Electric Ltd—one of the wide range of fires of various types made by this firm.* (Centre) *The 1500 W Dimplex two-element infra-red fire which won the premier award in the Domestic Section at last year's A S E E Exhibition.* (Right) *An attractive convector heater by Belling & Co Ltd, who were one of the pioneer firms in the field of electric heating*





Portable and Heating Appliances

C Richards *

It will be obvious that this sector of the domestic electrical appliance industry covers a vast range of activities, not all of which can be dealt with in great detail in this issue. Although it had its fair share of difficulties following the end of World War II, the small appliance industry suffered less from the hire purchase and credit restrictions which so greatly hampered the sales of major appliances. This fact, coupled with almost complete freedom from foreign competition, greatly encouraged not only the rapid development of new products, but also the redevelopment of products traditionally used by the housewife. It is possible that her war-time activities and lack of working time in the home, to say nothing of the shortage of domestic help, accelerated the demand for all forms of domestic mechanisation. Manufacturers who have concentrated on this aspect of the housewife's needs have reaped a rich reward.

The greatly improved standard of living of all classes of the community has enormously affected the scope and the market for such appliances. Greatly increased production and sale have contributed in no small measure to the stabilisation of really competitive prices and there is no reason to believe that, in spite of high saturation levels in some products, there is an excess of production capacity or that the small appliance industry is in any immediate danger of suffering from the many evils which such a condition breeds.

More Favourable Export Outlook

Unhappily, prosperity in the home market is not matched by a similar state of affairs in the export field. Sales in a vast number of overseas countries in the post-war years were limited only by the availability of capacity and, more important, of raw materials. The contraction in the number of those markets brought about by artificial restriction, the industrialisation of many of the smaller countries, coupled with the replaced industrial capacity of many traditional Continental competitors, have all contributed to the British manufacturers' difficulties.

Nevertheless, there is reason to hope that the lessons of the past have not been ignored. It has already been recognised that the ability to compete effectively in the markets of the world depends upon a prosperous and stable home market. It is unlikely that the great body of responsible manufacturers will allow the ease and prosperity of conditions at home to hamper the keener and more aggressive activities demanded of them abroad. Indeed, it would obviously not be in their long-term interests to do so. The full employment at home which creates the spending power of the masses depends entirely upon our ability to export.

One noticeable and commendable feature in recent years is the industry's growing knowledge of the peculiarities of individual overseas markets and its willingness to adapt its products to them. Promotion and instruction literature and sometimes display cartons written, edited and even sometimes printed in the country of destination, are all steps in the right direction. Varying standards of approval still present many complications, but there is again a noticeable tendency to design the basic product with these specifications in mind.

Nevertheless, it must be accepted that there are some appliances for which there is a substantial demand in the U K, probably due to climatic conditions, which cannot enjoy a similar popularity abroad where in so many cases either climatic or economic circumstances, or both, are not comparable. This refers particularly to many space heating appliances and to electric blankets and pads.

Blankets and Pads

In this field the increase in demand has probably been more spectacular than in most others. As recently as 1950, total annual deliveries to the United Kingdom market were reported by the Board of Trade to be no more than 90 000 units. By 1959 this had increased more than eleven times to 999 000 units. The present estimated level of ownership at the end of 1959 is 14 per cent of households owning one electric blanket, and a further 4 per cent owning two or more. This could indicate a quantitative level of ownership of about 3·5 million blankets, but even this figure may well be higher.

The electric blanket is important as a gift item. A recent comprehensive national survey produced the fact that no less that 36 per cent of all sales are made with this purpose in mind—a fact which helps to explain the unusually high standard of packaging and presentation.

The same survey showed that, temporarily at least, the middle and upper classes are by far the greatest purchasers. Clearly there is room for a very great expansion of sales and a continuation of the somewhat spectacular pattern of demand which the industry has enjoyed over the last ten years.

The 'kite mark'—a symbol permitted to be used only by those manufacturers adhering to the relevant British Standard Specifications covering performance and safety—is now almost universally adopted and certainly recognised throughout the world.

Space Heating Appliances

Ten years ago, the radiant fire in varying forms was the principal electrical heating appliance available to the British public. The inconvenience and increasing cost of solid fuels, smoke abatement legislation and many similar factors have since stimulated the development of a great variety of alternatives. The electrical industry is playing a great part in the battle of the fuel giants for this enormous space heating market—a market which, once again, is dominated by local climatic conditions.

In a country which was until quite recently almost wedded to the open coal fire, the unabated and ever-increasing demand for decorative and 'coal effect' fires is

* Managing Director, Morphy-Richards (Cray) Ltd

understandable. Additionally, all forms of background heating—particularly those which can be thermostatically controlled—are rapidly gaining in popularity. In recent years, considerable development has taken place in the design of convector heaters, combination convectors and radiant bar fires, the oil filled radiator, the fan heater, and in various low temperature background heaters such as carpet underlays and installed under-floor heating.

In quantitative terms it would appear from a recent survey on the levels of ownership that something over eleven million portable electric heaters are now owned in Great Britain. In addition, about three million convector heaters, wall-mounted fires, and oil-filled electric heaters are in use. Although production statistics available for this market have not been sufficiently consistent in earlier years to be of much value, it would not be inaccurate to say that the level of ownership of space-heating appliances has doubled in the last four years.

Portable Cooking Appliances

If one includes under this heading not only cooking appliances but also various food preparing machines such as kitchen mixers, toasters, coffee percolators and the like, the rate of growth has probably been less spectacular. The present ownership of electric kettles at about 37 per cent of all households, or some 5·5 million users, is probably the highest in this field.

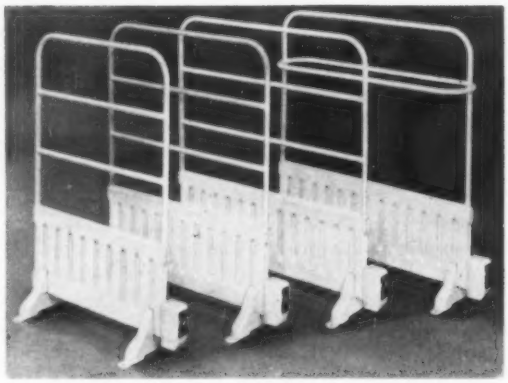
The extensive preference for toast accounts for an increasing demand for automatic toasters. The development of this item since the war in a reliable inexpensive form has substantially outpaced the demand for the non-automatic type, and will no doubt continue to do so.

The present level of ownership of food mixers, currently estimated at about 3 per cent of all households, is a most disappointing figure. It is probable that the comparatively high cost of installation compared with the labour saving element in the ordinary household is a deterrent, but one would expect also that the traditional English plain cooking is a contributory factor.

Electric Irons

This item represents one of the most stable elements in the small appliance field. The average annual production rate over the last ten years of some 2·5 million units is reasonably constant. The popular demand is for a heat-controlled dry iron of medium weight. The advantages of the light-weight models have not been too readily accepted by the British housewife, although there is a steadily increasing sale for the light-weight steam and dry iron.

The present level of saturation is reputed to be 85 per cent, of which steam irons account for 12 per cent—a figure which has more than doubled in the past two years.



A range of oil-filled 'Towel-Rad' combined radiators and dryers by Hurseal Ltd

Dry Shavers

Manufacturers' deliveries to the United Kingdom market have remained steady over the past four years at approximately one million units a year. It is estimated that one male in every four uses this appliance.

The better known British manufacturers dominate this market, largely as the result of huge promotional expenditures with a consequential uplift in retail prices, a factor which may to some extent have retarded a full exploitation of this increasingly popular appliance. The introduction of a new, relatively inexpensive and efficient shaver seems likely to lift deliveries to a new high level.

Hair Dryers

The wide use of this now popular appliance is probably due to the introduction in the early 1950's of a number of inexpensive models, prior to which the total annual U K deliveries amounted to no more than 120 000. The present rate is very nearly 500 000 a year, and saturation has risen to 23 per cent.

This is necessarily a very brief and general review of but a few elements in the United Kingdom small appliance industry—an industry already committed to an increasingly vigorous attack on world markets. Given reasonably stable conditions, both at home and overseas, the British manufacturer is in no doubt as to the urgency of the task and his ability to meet the challenge successfully.

(Left) *A combined heater and firescreen of unusual design—the 'Flamenco'—by the Midland Electric Manufacturing Co Ltd.* (Centre) *The 'Thermopanel' radiant glass panel heater by E K Cole Ltd.* (Right) *Another distinctive design—the Creda 1 kW heater*

The Growth of the Domestic Laundering Industry

H J Furness *

THE basic operations involved in the laundering process —washing and rinsing, drying and airing, and ironing— did not change significantly for centuries; and although various crude appliances were used, no real development in domestic laundering equipment was possible until after the inventions of the electric heating element, the electric motor and the thermostat.

Despite the potentialities which these devices opened up, the growth of the domestic laundering equipment industry in Britain was very slow, and even the most rudimentary appliance, the wash boiler, was being sold only at a rate of 40 000 to 50 000 a year in the 1930's.

In 1938, total ownership of washing machines in the United Kingdom was no more than 300 000, partly due to the conservative characteristics of the British housewife, but more especially to the relatively high price of the appliances.

Washing Machines

Although there was considerable expansion and evolution before the war in the field of low price ancillary equipment such as wringers and electric irons, it was not until 1948 that any determined effort was made to exploit the potential demand for domestic laundering equipment by the introduction of a mass-produced low price washing machine suitable for the average home.

In 1948 over 90 000 machines were sold in the United Kingdom, and in the following year sales were more than double.

Despite the adverse economic conditions in the post-war period, not only in Britain but in a large part of the world, the industry showed a steady growth and in a period of ten years a major new industry has been established.

By 1959 nearly one and a quarter million machines were sold in Britain and exports reached record levels.

There is no doubt that the washing machine is not only accepted as an essential part of the household equipment in Britain and Europe, but it is also receiving increasing acceptance in the under-developed parts of the world. As standards of living rise in these areas, the need for household equipment must inevitably assume greater importance, not only as the visible sign of greater affluence but from the necessity to utilise mechanical appliances to replace the shortage in the home of labour which is already being quickly absorbed by the growth of industry.

The penetration of 40 per cent in Britain provides the assurance of a continuing healthy 'first purchase' demand which is already being supplemented by a growing replacement market.

The existence of this continuing high demand is essential for the maintenance of prices at levels which will not only ensure wide acceptance among all income groups in Britain, but which are sufficiently attractive to enable importations to be made into overseas markets at competitive prices.

Rising Demand for Automatic Machines

The success which has attended the efforts of exporters illustrates clearly the ability of British manufacturers to produce and sell in world markets in competition with other countries, and with the improving designs which are now being developed there is every reason to support the view that export volume will show substantial improvement.

In 1948 the basic requirement was for a mass market which would permit low production costs. This inevitably meant the introduction of a simple appliance.

The creation of large volume demand then made it possible for manufacturers to concentrate their attention on the evolution of more advanced types of machines. This natural process of evolution was stimulated by the growth of competition, which developed as a result of the general acceptance of washing machines as an integral part of household equipment.

Thus, the simple machine with a hand operated wringer gave way in popularity to machines incorporating power wringers, although a substantial market still remains for the former type of machine, not only in the lower income groups at home but in markets overseas in many of which the process of type evolution has not yet developed.

The relative inefficiency of wringing as a means of drying soon gave rise to the introduction of a combination machine which effectively encompassed two of the basic laundering operations.

It is already clear that the combination machine will largely displace the power wringer type, and there is evidence of a rising demand for semi-automatic and automatic machines, produced in sufficient quantity to make possible a price within reach of the average family. How rapidly this evolution will take place is difficult to assess.

Price factors, although less important than in the past, are still a major influence in the buying decision. We should not suppose, therefore, that automatic machines will eliminate the simpler types from the market. Even in the U S A, where almost every housewife already owns a washing machine, there is still a large—although diminishing—market for non-automatic types.

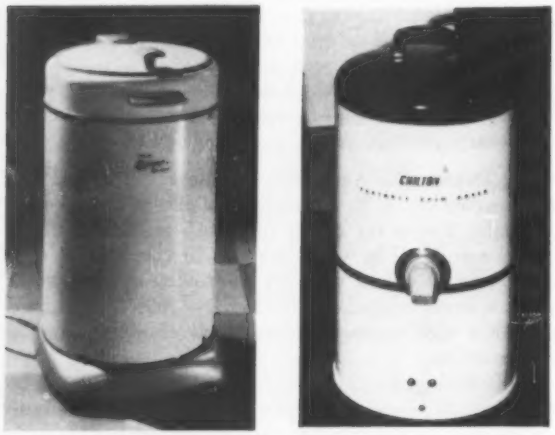
However, there is little doubt that the automatic washing machine will in due course dominate the market in Britain, and that this pattern will be reproduced in the advanced countries of Europe and the Commonwealth.

Spin Dryers

In many homes the major laundering problem is drying rather than washing; and this fact, together with the

* Commercial Research Manager, Hoover Ltd

relatively slow type evolution of washing machines, has given rise to a large demand for spin dryers, which are used not only in conjunction with the simpler types of washing machine but are also being purchased to an increasing extent by housewives who still wash manually.



Two typical spin dryers: (left) *the Creda 'Debonair'.* (Right) *The portable Chilton machine*

Until 1957 the large majority of sales had been based on manual or power-operated wringer machines, and both these types, although performing the operation of water extraction, are relatively inefficient when compared with spin dryers. Thus there is a very considerable number of machines still in the market, both at home and abroad, and so long as a substantial proportion of them remains, there is every reason to believe that the demand for spin dryers will be sustained for some time to come.

With the rapid movement toward combination and eventually to automatic machines, both of which incorporate spin drying as an integral part of the design, there will be a gradually reducing demand for the separate spin drying unit.

Tumble Dryers

In assessing the future potentialities of the market, we must differentiate between wringers and spin dryers on the one hand, and tumble dryers or drying cabinets—which perform a different function—on the other.

The former will to a large extent be eventually displaced, as their function will be performed by the advanced types of washing machine; the latter meet a basic requirement which even the most advanced type of washing machine cannot fulfil without considerably increasing both the price and size of the product.

The present ownership of tumble dryers is very low, both in the United Kingdom and in Europe generally. It is surprising, in view of the adverse climatic conditions, that sales have not reached greater proportions, although there is now evidence of a growing interest in this type of appliance.

Certainly one of the reasons for the low sales is the problem of producing an efficient machine of a size which can be accommodated in present-day kitchens.

It may well be that this appliance cannot enjoy the prominence in the market which it has achieved in the U S A until there is considerable change in the traditional standards of kitchen design.

The problem of kitchen size to accommodate the range of household appliances now considered necessary by the average housewife is one which is not confined to Britain, but is equally true in most of Europe. This factor is receiving increasing attention in the design of new homes, although there is still insufficient provision made for the revolutionary changes which are taking place in the approach to household chores.

Ironers

The technical problems associated with home laundering, covering the cycles of washing and water extraction, have now been overcome. The major problem which now besets manufacturers of home laundering equipment is that of developing a mechanical ironer which will complete the cycle.

A great deal of effort has been and is being directed towards the design of a satisfactory ironing machine. However, American experience with this appliance is most discouraging. In 1950, 400 000 were sold in the United States, and sales have gradually deteriorated since then to less than 40 000 in 1959.

[*Continued on page 71*

(Left) *The 'Hoovermatic' twin-tub washing machine and spin dryer.* (Centre) *The Morphy-Richards 'Astral' spin dryer.* (Right) *The English Electric tumbler dryer*

NOTE. Other newly-introduced models of domestic laundry equipment are reviewed in 'New Equipment' on pages 75 and 76

The Electric Cooker Industry

V Coffee *

It can be said that the use of electricity for cooking is both comparatively old and relatively new. It is on record that electricity was used for this purpose in Great Britain during the later years of Queen Victoria's reign, and in 1894 the members of the Institution of Electrical Engineers attended a banquet which was cooked electrically. This did not mean that electricty was 'in use' in any general sense; to the public it remained a fuel neither understood nor appreciated, and it was to be many years before this situation changed. Even large cities such as London were without an adequate supply of electricity, and it was only after the first World War that a proper supply system came into being and with it the realisation that electricity had a part to play in the home equally as important as in the factory.

The construction of the National Grid made electricity available at reasonable cost and the Electricity Act of 1926 permitted the electricity authorities in Britain to hire-purchase domestic electrical appliances, but even so it was not until about 1930 that the sale of electric cookers was actively promoted, although one enterprising manufacturer had earlier opened an electrically-equipped restaurant in London as an advertisement for this form of cooking.

Two pictures showing that electric cooking is not a recent development. (Left) *A very early 'Tricity' cooker about the time of World War I.* (Right) *A later development: a double hob and oven 'Tricity' model about* 1929

The performance of the electric cooker in the early days left much to be desired; boiling plates were slow to the point of tedium and the early switches could not give the ease of control and the accuracy of setting provided by the gas flame. Often it was necessary to pull the pan to the side of the boiling plate to improve the chances of simmering. Ovens tended to be slow in heating up and small in size.

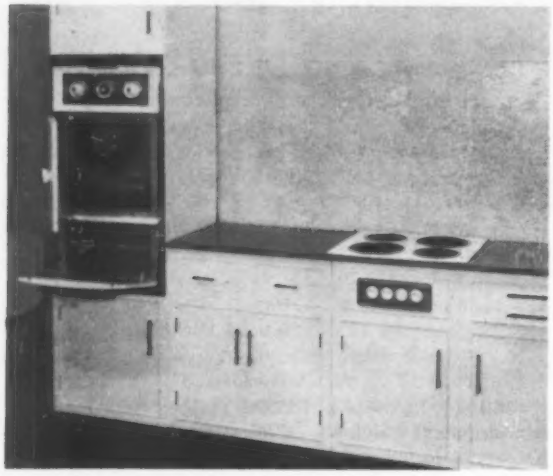
These were problems that were to remain with the industry for many years and it says much for the enthusiasm of the early pioneers and salesmen that these obstacles were gradually overcome and sales showed a steady upward trend. Nevertheless it must be admitted that in the process many of the explanations of the salesmen became accepted by the designers themselves, to the detriment of progress and the wishes of the public. It may, for example, be possible to 'pack' a small oven, but there is no real merit in doing so since a large oven is more convenient, remains cleaner, meets no sales resistance and can be cheap and economical. There are signs that the traditional ideas are losing ground and that design and development problems will be tackled strictly on their merits.

Throughout the 1930's the sales steadily increased and more and more refinements made their appearance. The 3-heat switch on the oven was replaced by the thermostat, and this was followed in 1935 by the first tubular plate—a development which was of immense importance for the industry, offering as it did improved boiling time and, perhaps just as important, the visible indication of speed, so long the prerogative of the gas flame. No special pots or pans were needed and when, ten years later, these plates were teamed with the infinitely variable control or simmer devices, the electric cooker had become a really serious challenge to other fuels.

The period since the second World War has shown a marked increase in the tempo of electric cooker sales, and at least one home in four is believed to use this form of cooking. Even more encouraging is the high proportion of new homes where electric cookers are being installed, and in the 1958/59 Gas Council report, it is recorded that the net increase in the number of domestic gas consumers was only 4 000 at a time when 200 000 new houses were built. This would seem to indicate a swing to electric cooking in new homes, where the special advantages of the modern fuel would be particularly appreciated. The progress made in the last few years has been stimulated by the desire, particularly among the

* Director, Tricity Cookers Ltd

younger people, for the latest and cleanest method of cooking; by the provision of up-to-date electrical appliances for domestic science classes, and by the importance which the supply industry has attached to the promotion of cooker sales, which are now in excess of 400 000 a year. The industry has also gained from the current trend towards the sales of more expensive cookers.



One of the latest models from the 'Tricity' range: the 'split' cooker which can so easily be built in to a suite of kitchen furniture

The present phase, in which design, quality and special features play an increasing part in deciding the sale, is therefore to be welcomed. This trend towards the more expensive cooker was illustrated in a recent paper presented at the 1960 Harrogate Sales Conference promoted by the Electrical Development Association, which showed that since the relaxation of government controls the demand for low-priced cookers had fallen from 35 per cent to 14 per cent of the total sales, and this state of affairs should continue.

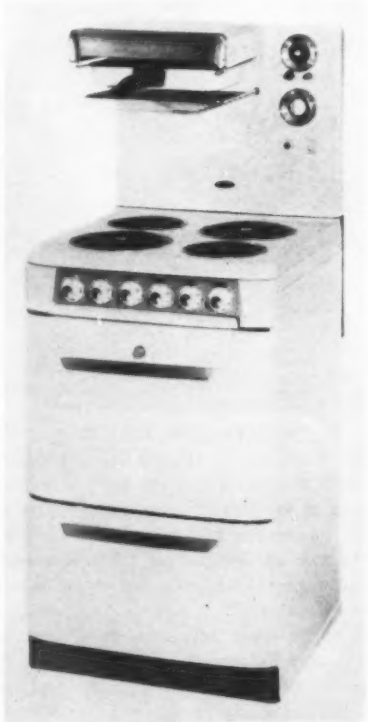
The importance attached to kitchen planning and design and to labour-saving devices is increasing very rapidly each year. It has long been said that the American builds his house around his kitchen and the Englishman around his living room, but there is a clear indication that the housewife will expect her kitchen in future to be not only labour saving but also smart and attractive, and in this the cooker will have to play its full part. Already many cookers are attractively styled, and about half of those now sold are fitted with oven time-switch control, but the further opportunities in this direction are still immense.

If the electric cooker industry moves with the times, then there is without doubt a bright future ahead, and before many more years are past, it will undoubtedly attain parity in sales with the gas industry. It is however vital that at all stages the manufacturers should have the understanding support of the supply authorities, for if the most modern techniques and ideas are to become available to the public, the important questions of maintenance and standardisation must be kept in the right perspective.

For many years, cooker design was hampered by the requirement that all plates and grills should be interchangeable. This standard conferred many benefits and in its early days admittedly kept replacement costs within bounds. In the course of time, however, this arrangement prevented the adoption of more modern ideas and techniques, and actively tended to keep up replacement costs. In this connection it is interesting to note the tremendous strides that have been achieved in the last two to three years following the introduction by one cooker manufacturer of a number of Continental ideas completely new in this country. This breakaway from traditional design led to a number of new and challenging ideas being introduced by manufacturers: boiling plate costs and sizes, boiling trims, spillage disposal, new methods of fixing radiant and solid plates and improvements in performance, the size of the grill and its position—all these have come under scrutiny and there can be little doubt that as a result the public to-day is able to obtain electric cookers that provide better value, greater ease, greater economy and speed than ever before. At the same time replacement costs have in many cases been radically reduced. The stimulus of new ideas and better techniques is essential to a modern thriving and competitive industry, but the problems this creates for the supply authorities must also be recognised, and it is essential that there should be full consultation and understanding between the two sides of the industry.

The wisdom of looking into the 'crystal ball' of the future and then going into print is always open to question, but certain trends do seem clear. For the majority of purchasers, a 'free standing' cooker will continue to be essential and will follow the ideas that have emerged in

Contrasts in modern cookers. (Left) *The Falco 'Petite'—the smallest model of a wide range of cookers by the Falkirk Iron Co Ltd.* (Right) *The outstanding GEC 'Supreme' cooker*



the last two or three years, with great attention being paid to clear functional lines, smart appearance, larger ovens and warming chambers and, of course, modern time- and labour-saving devices. The 'rotary spit' is probably destined to enjoy a considerable vogue, and before long boiling plates will be thermostatically controlled. All these additional features and trends are to be welcomed since they stimulate the desire for the latest product, and there is little doubt that the present life of an electric cooker—which now averages around 19 years—is too long if the housewife is to enjoy the advantages of a progressive industry.

It also seems likely that the 'built-in' cooker will make some inroads during the next few years. In the U S A it has captured nearly 50 per cent of the market after only a few years, and although progress in Britain is likely to be much slower, one manufacturer is already in the market and others will follow. In 1947 the Chairman of one of the Electricity Boards welcomed this new approach as providing a more secure lead, since in his opinion it is a method more suitable to electric than gas cookers. It may however be necessary to consider the marketing of this product, since the importance of the builder and architect in this connection cannot be overlooked. In the U S A they account for 80 per cent of the sales.

Looking into the more distant future, the electronic cooker will surely take its place in the British kitchen. It is ideally suited to the 'built-in' unit and its speed and cleanliness will revolutionise the present practice. This development is probably the most important we shall see in our lifetime, and it would give the electrical industry undisputed leadership.

(Left) *The Jackson 'Highline' cooker, with eye-level grill*
(Right) *A representative model from the 'Carron' range made by the Carron Company*

We can therefore look forward with confidence to the tendency for the cost of other fuels to rise more steeply than that of electricity; to the advent of nuclear power; to the interest in clean air; and to the greater freedom which automatic control gives the housewife. All these will be important factors in the development of a great industry, the rate of progress of which will depend not only on these considerations, but also on the enthusiasm and knowledge of showroom staffs and the presentation of the product through attractive advertising.

The creation of a successful modern industry depends not so much on a battle of wits as on the offer of service with a pledge of good faith, and the electrical cooker industry is tackling the future in this spirit.

THE GROWTH OF THE DOMESTIC LAUNDERING INDUSTRY (*Continued from page 68*)

Two factors would appear to explain this rejection by the American public of an advanced design : the increasing use of non-iron fabrics, and the high degree of skill and dexterity required to operate the appliance efficiently.

There is no doubt that housewives would buy in large volume a machine which would significantly reduce the time spent on ironing, but in the author's opinion no technical solution has as yet been found.

Revolution of the Laundering Process

In Britain there has been a rapid development from the simple types of machine to highly advanced mechanisms, during which the many technical problems associated with their efficient and trouble-free operation have been solved. There is thus a tremendous fund of knowledge and experience available which will be used to advance the techniques already established.

The development of the industry has done a great deal to revolutionise home laundry operations and has removed much of the drudgery, but it has done little to change the actual functions of washing, drying and ironing. Fundamental research into these complex processes and the phenomena involved, of which very little is known at present, promises to lead to radical new methods.

Intensive study into the nature of dirt, the nature of fabrics, the phenomena of adhesion and the chemistry of washing, together with the rapid developments which are taking place in the field of detergents and synthetic fibres, will almost certainly transform the nature of the laundering problems. And in planning for the future of our industry, we must constantly be examining the implications of the findings in these fields—for the real revolution is yet to come.

'Going Electric' at the Ideal Home Exhibition

EVERY year the Ideal Home Exhibition—the great annual attraction organised by Britain's *Daily Mail*—throws more and more emphasis on electricity in the home. Every year the stand space occupied by domestic electrical equipment grows bigger and bigger, as the following comparison shows:

	square feet	*square metres*
1959	27 942	8 520
1960	35 148	10 700

These figures tell their own story, and yet not the whole story. Not so very many years ago, the electrical section was compactly housed in a corner of the Grand Hall. This year it has not only expanded into a very considerable proportion of the total ground floor space in the Grand Hall, but it has also—and very appropriately—filled a major part of the Grand Hall Gallery devoted to Labour Saving, and is also plentifully represented in the model houses, and in the Practical Household section in the Empire Hall.

The Main Trends

What are the main trends in the British domestic electrical appliance industry which this year's exhibition has revealed? This is a fair question, since the electrical exhibitors at this event—most of them BEAMA member-firms—represent the main strength of this important industry.

The principal trend is undoubtedly towards the 'automatic home'. The beginnings of this trend were discernible last year, but the present widespread application of automatic, thermostat and time-switch control to so many and varied applications of domestic electricity marks this year as the beginning of the era of the automatic all-electric home.

Side-by-side with this trend is the increasing emphasis on labour saving—exemplified this year by the introduction of many new dish-washing and clothes-washing machines;

The heating section of the E D A stand showing a variety of space heating appliances, with a floor-warming (carpet underlay) display on the extreme left

Some of the cookers on show on the E D A stand, with a glimpse of the refrigerator section in the background

improvements in suction cleaners designed to make them easier and more convenient to use; more food-mixers with a still wider range of uses, and in the home workshop field the addition to the ranks of power drills of a versatile new model with some highly individual features.

The foregoing items are, of course, only a few examples of certain aspects of current developments. In every field of domestic electrical application—space heating, water heating, cooking, refrigeration—progress has been equally intense, and improvements in styling, design and efficiency equally decisive. Perhaps one can sum up the principal impressions of this year's exhibition by saying that while the well-established uses of electricity are being ever more widely extended, new concepts of electricity in the home are now becoming accepted as essentials in the modern home, be it large or small; modest or luxury.

As always, the Electrical Development Association staged a very large and comprehensive exhibit showing nearly 150 different appliances, with clearly defined areas of the stand devoted to cooking, water heating, home laundry equipment, refrigeration, space heating, and small appliances. There was also a special display emphasising the merits of electric floor warming—a system of electric heating which is proving very satisfactory in new housing estates in several places in Great Britain. For existing houses, electrically heated carpet underlays are a practicable and efficient alternative method.

Light and Heat—The Earliest Domestic Needs

While on the subject of space heating—probably the earliest application of electricity to domestic needs after the introduction of electric lighting—one may notice the still wider popularity of infra-red heaters; there were many more models to be seen than at last year's exhibition, and most firms producing them were showing models with built-in cord operated switches—a feature which makes them particularly suitable for installation high up on the walls of bathrooms and kitchens.

As we noted last year, convector heaters—both natural and fan-assisted types—are also increasing in popularity and numbers. In fact, the radiant element and reflector type of electric fire seems to be losing ground slightly, although its portability and lower cost will always commend it to a great many buyers.

Two Main Cooker Requirements

With cookers, the emphasis is on two main aspects: speed and flexibility, and automatic control. Practically every cooker manufacturer now offers models with thermostat and time switch control which switch themselves on at a pre-set time, maintain the correct cooking temperature and switch themselves off when the food is cooked. Alternatively, separate control units are available for use with earlier non-automatic cookers.

A new version of the Creda 'Mercury'* was shown which incorporates a rotary spit in the oven; this can be used either in free air or with the glass door of the oven closed.

In the luxury class of cookers was the Belling 'Classic'—the largest model in the exhibition, with a high-level oven and an extra-large hot cupboard.

The complete range of the well-known Jackson cookers was shown by the Electrical Division of Radiation Ltd. One model has four 'Speedring' hotplates, one of them with a higher loading to give very high-speed heating. Another Jackson feature was a mobile plinth with castors which can be fitted to give an extra 2·5 in (63·5 mm) of height to suit the taller user.

The 'split' cooker, with separate hot plate and oven which can be built in to a uniform style of kitchen units was again in evidence on the Tricity stand, together with other attractive models in the Tricity range.

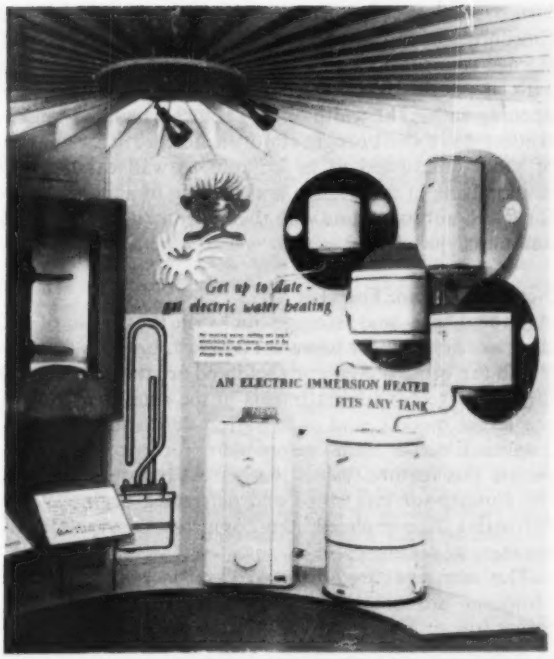
The General Electric Co Ltd introduced their new 'Splendid' cooker—an inexpensive model with the modern features of eye-level grill, glass oven door, removable drip tray and Superspeed hotplates; Revo Electric Co Ltd featured their 'Revo-luxe' remote control cooker and the 'Family Special', and the English Electric Co Ltd had an impressive display of their comprehensive line of cookers.

The Labour-Saving Section

In addition to their principal stands in the main electrical section, many of the firms also had large stands in the Labour Saving section in the gallery where they featured and demonstrated their relevant products, and a survey of this section gave clear proof of the great expansion which has taken place in this field.

English Electric Co Ltd, for example, made a big feature here of the new 'Liberator' washing machine described on page 75 of this issue. Similarly, the new Burco Twenty-One double-tub machine (see page 75) was the outstanding exhibit on the Burco stand, accompanied by the 'Tumblair' drying machine and two electric wash-boilers.

Established models—such as the Ada-Matic combined washer and spin drier; the Hoovermatic and the Hoover Mark II and Mark III machines; the Creda 'Debonair' spin dryer; the Goblin washing machine and 'Spin-Quick' drier combination set; the AEI-Hotpoint range



The electric water heating section on the E D A stand. On the left the use of immersion heaters is demonstrated by sectioned models and diagrams; on the right are six different types of self-contained water heaters

of Countess, Empress and Princess washing machines with wringers; and the Parnall washing machine, the new Auto-dry tumbler drier and the Thor 'Automagic' combined washing machine and spin drier marketed by the Electrical Division of Radiation Ltd—were prominently featured on their respective stands.

As already mentioned, dish washers are becoming increasingly important in the domestic field, and representative makes exhibited included fully automatic models by Easiclene Porcelain-Enamel Ltd, the 'Dishmaster' by Kenwood Manufacturing (Woking) Ltd, and the Ada by Ada (Halifax) Ltd.

Newcomers to the ranks of suction cleaners and floor polishers were Tricity Cookers Ltd, who have introduced a new idea in a suction polisher. Other new models which have been previously described in our pages included the Electrolux and the Hoover.*

There was a noticeable increase in the number of refrigerators on show, and some names well known for other domestic appliances are now appearing for the first time in this field. One of them is Tricity, who have introduced a 4·2 cu ft (0·118 m^3) refrigerator to match their Viscount and Marquis cookers. It has the somewhat unusual feature of four wheels and a brake.

Other newcomers are the Simplex Electric Co Ltd with two models, and Ada with their new 'Slendaline'.

Speaking generally, the smaller models are still the most popular in this country, and refrigerators of less than 4·5 cu ft (0·13 m^3) accounted for over 80 per cent of sales last year.

It can be taken that this is largely dictated by the smaller floor spaces available in many homes, and this in

* THE BEAMA JOURNAL, **66**, No 4, p 155

* THE BEAMA JOURNAL, **67**, No 1, p 38

turn has influenced the current design trends which have concentrated on providing the maximum amount of storage capacity in a cabinet as compact as possible and with a smooth streamlined exterior, usually with the door opening within the width of the cabinet. The same considerations have also brought about an increase in the number of models designed to be built in to wall cabinets, so economising in floor space and helping to achieve a uniform and unbroken line with the built-in kitchen cabinets and units.

New Refrigerator Features

As noted last year, storage racks on the inside of the door are now almost universal practice, but new features which are being increasingly adopted are the provision of large-size freezer compartments in the smaller as well as the larger models, and push-button defrosting. The new English Electric 'Slim-line' models, for example, incorporate this feature. When the defrost button is pressed, the compressor unit stops and defrosting begins. When defrosting is completed, the compressor automatically resumes its normal cycle.

The two new 'Iced Diamond' refrigerators by AEI-Hotpoint are notable examples of the trend towards larger freezer and chiller compartments.

A new and very interesting stand was a joint effort by the General Electric Co Ltd and the Walpamur Co Ltd. The theme was light and colour in the home, and the exhibit was designed to show how the correct use of both media gives pattern and atmosphere to the decorations and furnishings. More than two dozen different lighting ideas were displayed, including several applications of the new GEC Variform range of fittings and various examples of pelmet and other kinds of concealed lighting. Osram lamps and fluorescent tubes were, of course, used throughout.

An interesting novelty was to be seen on the Singer sewing machine stand in the form of an electric sewing machine powered by a bank of silicon photo-voltaic cells which converted light energy directly into electrical energy. Although in this exhibit the light was provided by lamps, the objective is to utilise sunlight. At the moment the project has no commercial application, but it affords a significant pointer to the possibility of a home of the future which could be entirely independent of any outside electricity supply.

Highlights in a Forward-Looking Industry

This necessarily brief review of a most interesting exhibition can only be representative, not exhaustive. It does, we hope, serve to highlight the current trends in a progressive and forward-looking domestic appliance industry and to supplement the articles dealing with particular aspects which appear elsewhere in this issue.

The 1960 BEPC

THE Twelfth British Electrical Power Convention will be held this year at Bournemouth, on the south coast of England, from 30 May to 2 June.

The President of the Convention is the Rt Hon Viscount Chandos, DSO, MC, (Chairman of Associated Electrical Industries Ltd), who has chosen as the theme of the Convention 'The New Horizon'.

He will deliver the Presidential Address on Monday afternoon, 30 May, and the speakers and subjects for the sessions starting on Tuesday morning, 31 May, will be:

The New Horizon—Electrical Manufacture

The Hon H G Nelson, M INST C E, M I MECH E, M I E E, Managing Director, English Electric Co Ltd.

The New Horizon—Electricity Supply

Mr C R King, C B E, COMP I E E, M INST F, Chairman of the Electricity Council.

The New Horizon—Electrical Export

Mr E V Small, Chairman of the Export Panel, British Electrical and Allied Manufacturers' Association, and Joint Managing Director, Associated Electrical Industries Export Ltd.

The New Horizon—Electricity in the Home

Mr T E Daniel, MENG, M I MECH E, M I E E. Chairman of the British Electrical Development Association and Chairman of the North Western Electricity Board.

Electrical Forum

Question Master: Viscount Chandos.

Members of the Panel:

Miss Mary George, M B E, B A, Director, Electrical Association for Women.

Mr A R Cooper, M ENG, M I E E, M INST F, M R I, Member for Operations including Nuclear and Personnel, Central Electricity Generating Board.

Mr N Elliott, C B E, J P, M A, Chairman, South Eastern Electricity Board.

Mr S F Steward, C B E, M I PROD E, Director, British Electrical and Allied Manufacturers' Association.

The Annual Dinner will take place on the evening of Wednesday, 1 June, at which the principal guest will be the Marquess of Salisbury, K G, P C, F R S.

The Annual General Meeting will follow after the end of the Electrical Forum session on the last morning of the Convention.

The exhibition which in recent years has been staged concurrently with the Convention will not be held this year.

New equipment and processes

The Burco 'Twenty One' Washing Machine
To coincide with the 21st anniversary of the foundation of the company, *Burco Ltd*, of Burnley, Lancs, have introduced their 'Twenty One' combined electric washing machine and spin drier.

Burco say that the trend in Britain is towards the twin-tub type of washing machine, and they have therefore aligned themselves with this trend and have produced a combined washing machine with several special features. One of the most important claims made for this machine is the 'deep flow' rinsing. The drainage holes in the spin drier tub are at the bottom, and in use the washed clothes from the adjoining washing tub are packed into the spin tub, which is then filled to overflowing with rinsing water. Most of the soap or detergent foam is thus carried away by the overflow, and during spinning the remaining rinsing water flows down through the clothes and is spun out of the holes at the bottom, carrying with it any remaining traces of soap or detergent.

Constructionally, the outer casing of the machine is of mild steel, with a stainless steel tub in the washing compartment; the spinning cylinder in the drier is of aluminium, with a sealed outer container of aluminium which carries away the rinsing water.

The washing machine incorporates a ¼ hp split-phase motor driving the gearbox through a belt and the vane type pump continuously through a rubber friction pulley. The aluminium die-cast gearbox gives a reciprocating motion to the agitator. The spinner is belt driven by a separate ⅓ hp universal motor giving a nominal spinning speed of 2000 rev/min.

A two-heat immersion heater with a safety cut-out is incorporated, with loadings of 2500 W on 'High' or 750 W on 'Low'. The control panel carries a 4-position switch, a 'Heater On' warning light and a 4½-minute timer, the latter controlling the motor in the spinning tub. Lifting the lid of the spinning compartment breaks the motor circuit and applies a mechanical brake; the time taken to stop, with the spinner fully loaded, is stated to be 8 seconds. The machine handles 5 lb (2·3 kg) dry weight of washing.

Overall dimensions are: 18⅝ in (47·4 cm) deep front to back; 31½ in (80 cm) wide, and 30½ in (77·5 cm) high. Rubber castors make it easily movable.

Standard voltage ranges are 200/210, 220/230, 230/240 and 240/250 V, 50 c/s. The firm invite enquiries for any other voltage ranges.

Automatic Washing Machine by English Electric
Described by its designers as Britain's first mobile washing machine, the new Liberator produced by the *English Electric Co Ltd* has as its main feature a built-in six-wash programme giving exact washing treatment for practically all materials from cottons to the newest synthetic or man-made fibres.

After two simple controls have been set, the Liberator automatically heats the water, washes, rinses up to four times, spins the clothes dry and switches itself off. A seventh position on the control dial provides for spin drying only.

The Liberator is a single horizontal drum machine with a dry weight capacity of 6 to 7 lb (2·7 to 3·2 kg), with front loading; the drum speed is 60 rev /min when washing and 500 rev /min when spin drying. Drive is through a two-speed Vee-belt transmission from a continuously rated, drip-proof ½ hp single phase motor. Water-heating is by a 2·75 kW tubular sheathed immersion heater which is switched on automatically and controlled by a switch responding to the level of the water. Correct washing temperature is controlled by the automatic timer and a thermostat.

The machine is described as 'portable' because (a) it is fully mobile on a castor base, and (b) no permanent plumbing is needed, as a special tap adaptor is supplied for connection to the cold water supply. A hot water hose is also provided if the user wishes to connect to a household hot water system or to have a permanent plumbing connection. It need not be bolted to the floor, as it is claimed that any vibrationis controlled by the internal suspension system.

The cabinet is of welded sheet steel, finished in white or cream stoved enamel. The door frame is a solid die casting, and the inset window is moulded from thick heat-resisting glass. A safety feature is the removable door handle, designed to prevent anyone opening the door when the machine is running.

Overall dimensions are: 25 in (63 cm) wide; 22 in (56 cm) deep (back to front); 36 in (91 cm) high including the castor base. The drum diameter is 19 in (48 cm) and the net weight of the machine is 234 lb (108 kg) Standard models are for operation on ac mains of 200 to 220 V or 230 to 250 V; models for other ac voltages are available to order.

The Parnall Spin-Washer
This single-tub washer-rinser-spinner from the *Electrical Division of Radiation Ltd* was first introduced at the ASEE Exhibition reported elsewhere in this issue.

It is particularly compact, occupying a floor space of only 22 by 22 ins (59 by 59 cm), and standing 36 ins (91 cm) high, so that its top is flush with standard sink units. The net weight is 200 lb (90·7 kg).

[*Continued on next page*

(Left) *The Burco 'Twenty One' combined washing machine and spin drier. The washing tub has a removable lid (not shown in the photograph).* (Above) *The English Electric Liberator—a mobile automatic washing machine which requires no permanent plumbing connection.* (Right) *Closed view of the single tub Parnall spin-washer which well illustrates its compact sheerline design*

Designed to meet the demand for one machine that will wash, rinse and spin without giving the user the trouble of handling wet clothes, the Parnall Spinwasher has a timer which controls washing and spinning. Rinsing is carried out on an untimed cycle by the 'Clear-Flo' method exclusive to this firm, and the tub has an outer compartment which stores hot water and suds for use again.

Capacity is 7·5 lb (3·5 kg) of dry clothes in 8 gallons (36 l) of water. The clothes tub is of rust-protected sheet steel and rotates on a flexibly-mounted axis for vibration-free spinning. The spin-drier is integral with the wash-tub; the cylinder is 18·5 ins (47 cm) in diameter and spins at approximately 850 rev /min, driven through an external clutch. The motor is a standard capacitor-start 0·25 hp drip-proof type, and the drive mechanism consists of precision-made gears running in an oil-filled sealed casing. The timer is operated by a synchronous motor.

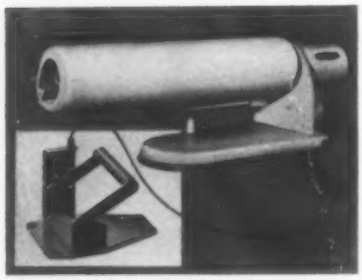
The cabinet is of rust-protected sheet steel, finished in white or cream stoved enamel, with three fixed wheels allowing movement of the machine for cleaning, and two adjustable feet to provide stability.

Water heating is by a 3 kW (or 2 kW to order) immersion element, with lamp indication and controlled by manually operated thermostat over the range 100 to 212 deg F (38 to 100 deg C). The heater control is interlocked with the motor and prevents simultaneous operation.

Machines are available for all standard ac mains voltages, and dc models without the automatic timer are also available at an extra charge.

Foot-Operated Rotary Ironer

Morphy-Richards Ltd have recently announced a new model of their rotary ironer which has a foot control to increase the speed and ease of operation. At the same time, the weight has been reduced to 34 lb (15·4 kg)—6 lb (2·7 kg) less than the previous model.



The Morphy-Richards rotary ironing machine and (inset) *the foot-control which leaves the user with both hands free to guide the ironing through the machine*

The great advantage of the foot-operated model is that the user has both hands free to guide the work through the machine and can sit in comfort while using it. The roller is 22 in (56 cm) long and 5 in (13 cm) in diameter, and is quilted to protect buttons and trimmings. The chromium-plated ironing shoe is bevelled so that the edges of garments and materials shall not get caught up.

The machine has a variable-heat switch and thermostat control; there is a control for free-wheeling the roller, and an additional motor switch provides for stationary pressing. A pilot light gives 'current on' indication. The finish is cream stoved enamel and overall dimensions are 32 in (81 cm) long, 14 in (36 cm) wide, 11·5 in (29 cm) high.

The ironer is for a c operation only and is available for voltage ranges of 100 to 120, 120 to 130, 200 to 220, 230 to 250 V. The loading is 1 100 W.

New Range of Squirrel-cage Motors

A new range of totally-enclosed, fan-cooled squirrel-cage motors with Class E insulation and complying with Draft BS A (ELE) 1629 has been introduced by *The General Electric Co Ltd.* Motors of up to 7·5 hp at 1 500 rev /min, and 5 hp at 1 000 rev /min, are available from stock; sizes up to 40 hp will be available shortly.

These 'D' frame machines have a continuous maximum rating in accordance with BS 2613 for a temperature rise of 65 deg C in ambient temperatures up to 40 deg C. They are interchangeable with ventilated machines ('C' frames) of the same rating complying with BS 2960.

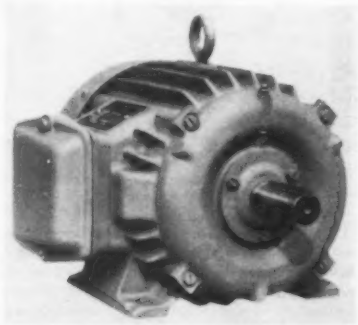
Further details can be obtained from The General Electric Co Ltd, Rotating Plant Division, Witton, Birmingham 6.

'Metrac' Live Line Indicator

This new indicator, developed by the research establishment of the Central Electricity Generating Board and now manufactured and marketed under licence by *Everett, Edgcumbe & Co Ltd,* Hendon, London, NW9, represents an entirely new approach to an old problem. The result is an instrument small enough to be held in one hand and which does *not* require contact with the conductor.

Two main types of 'Metrac' indicator have been developed and approved by the C E G B for use on its systems. One type is specifically for use on overhead power lines, and the other is for use at the spouts of draw-out or drop-down metal-clad switchgear.

The principle on which the 'Metrac' operates is that of detecting the electrostatic field set up by a conductor when it is energised by an alternating voltage. Detection is by means of an electrode which, in the overhead line model, is inside the instrument casing, and in the other model projects outside the casing. The indicator derives its power supply from self-contained ht and lt batteries, and the drain is so small that their life is stated to t e at least equal to their 'shelf life' of 6 months or so.



One of the range of new T E F C squirrel-cage motors with Class E insulation introduced by G E C

The instruments initially approved are those for the voltage ranges mainly used by the C E G B: 33 to 275 kV for overhead line types, and 22 to 66 kV for metal-clad switchgear types. Indicators for use on both higher and lower voltages are available, and these instruments have a number of other applications on normal industrial and domestic voltages.

All types give a positive indication by a pointer moving over two distinct areas of illuminated scale, one area coloured red and marked 'Danger Live,' and the other coloured green and marked 'Safe to Earth.'

One of the three new 'Metrohm' models—the metalclad type which is intrinsically safe in accordance with B S 1259

Insulation and Continuity Tester

The original model of the 'Metrohm' insulation and continuity tester made by *Everett Edgcumbe Ltd* has now been joined by three new types performing the same basic functions but designed for special applications. The original model was described in our issue of February 1959.*

The first of the new types is a metal-clad industrial model designed to withstand heavy usage in workshops. The bakelite panel which carries the components is recessed into a stout metal case with a hinged metal lid, and although slightly larger than the original model, it can still be held in and operated with one hand.

The second of the new types is a version of the metal-clad model which is intrinsically safe in accordance with BS 1259 and has been certified for use in methane and pentane atmospheres.

Finally there is a mains-operated model which can be permanently located on a bench or test rig. The bakelite panel is recessed into an angled die-cast housing; the battery is omitted and a transformer-rectifier unit is incorporated as the power source. The standard instrument is designed for ac supplies of 200 to 250 V 50 c /s, but it is also axailable for 100 to 125 V 50 c /s supplies if required.

Where repetitive testing is required, or where the operator needs both hands for the work under test, the instrument can be modified for operation by a foot or other type of switch.

* THE BEAMA JOURNAL, **66,** No. 1, p. 29

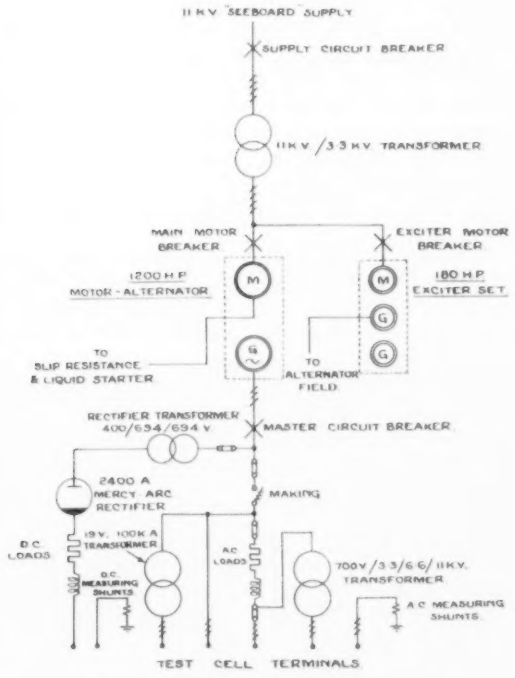
A Comprehensive Electrical Proving Station

FORMALLY opened by Sir Henry Self, K C B, K C M G, K BE, Comp IEE, at the end of March, the new electrical proving station and research laboratories of Allen West & Co Ltd at Brighton, Sussex, are admirably and comprehensively designed for their highly specialised requirements.

All through the fifty years of its existence, the firm of Allen West & Co Ltd has given high priority to research, and in recent years the scope of the work involved in the critical examination of operational stresses in industrial, marine and traction control gear has increased considerably. This has been brought about by, among other things, the more exacting requirements of British Standards which in turn reflect the demand for ever greater reliability and safety both in working conditions and emergencies.

The new proving station and research laboratories cover some 7 500 square feet (696.8 m^2) on the ground floor of No 5 building at the Allen West factories, and the Mechanical Testing Laboratory and Power Generating Room occupy a further 5 000 square feet (465 m^2) on the floor below.

The establishment comprises five main sections: the power generating room, the power testing station, the research and development laboratories, the standards room, and the mechanical testing room, and it will be convenient to deal with each section in that order.



Schematic of the main power supply circuits and equipment. Power is taken initially from the 11 kV supply of the South-Eastern Electricity Board ('Seeboard')

As practically all forms of switchgear and control equipment have to make and break electrical loads which vary in severity according to the service they are required to perform, a detailed knowledge of the behaviour of the contacts and the control of the arc under working conditions is an essential requirement for the proper design and construction of the equipment.

The Allen West power testing station has been designed for contactor and starter load-breaking tests, both for development and proving purposes. Small circuit-breakers up to 25 MVA can also be tested, and a 100 000 A 3-phase transformer has been incorporated for 'through-fault' investigations.

Power Supplies and Main Circuits

Test supplies are obtained from a 1 200 hp, 5 minute rated, 1 500 rev/min motor-alternator arranged for alternative winding connections to give 440, 750, 850 or 1 500 V 3-phase 50 c/s. The machine output, either direct or through a transformer delivering 3·3, 5·7, 6·6 or 11 kV, enables contactor and starter tests up to a maximum of 8·7 MVA to be undertaken; or the alternator can be routed to two mercury-arc rectifiers giving a maximum power of 1·44 MW at 600 V or 1·8 MW at 1 500 V d c.

The motor-alternator and its exciter set are supplied from a 3·3 kV switchboard connected via a 2 MVA transformer to the 11 kV supply from the Area Electricity Board.

The main motor is a slip-ring type with the rotor connected to a liquid starter via a slip resistance. The latter limits the peak current on the Board's supply feeder during the actual test. The exciter motor is a 180 hp direct-on squirrel-cage type and drives the main and pilot exciter.

The alternator output is taken, through a master circuit-breaker and a 'making' switch, into a room above containing the a c and d c loads and circuit-setting link boards. Finally, the output goes to the test cell, either direct or by way of the high voltage test transformer or the 100 000 A transformer.

The master circuit-breaker not only has to deal with the full alternator output current at 400 V, but must also be capable of interrupting a proportionally lower current at the maximum alternator voltage of 1 500 V. The most suitable commercially available breaker was selected: an air-break type rated at 250 MVA at 33 kV, having a good margin of safety and able to deal with the frequent operations necessary.

A special 'making' switch, based on a design by the Electrical Research Association, provides point-of-wave

selection. The switch consists of three separate spring-loaded contact arms mounted in a common framework which also carries the triggering mechanisms and a geared fhp motor to load the springs and raise the arms to their operating positions.

In test operation each arm is released by a solenoid which is energised by pulses from thyratron-triggered spark gaps, the instant of release relative to the alternator wave form being set by the selector on the control desk. Synchronising signals are derived from a tachogenerator coupled direct to the alternator shaft, and this also provides frequency indication at the control desk.

In order to give identical transients on each phase, the blue phase arm is arranged to close exactly a quarter of a cycle after the red and yellow phase arms.

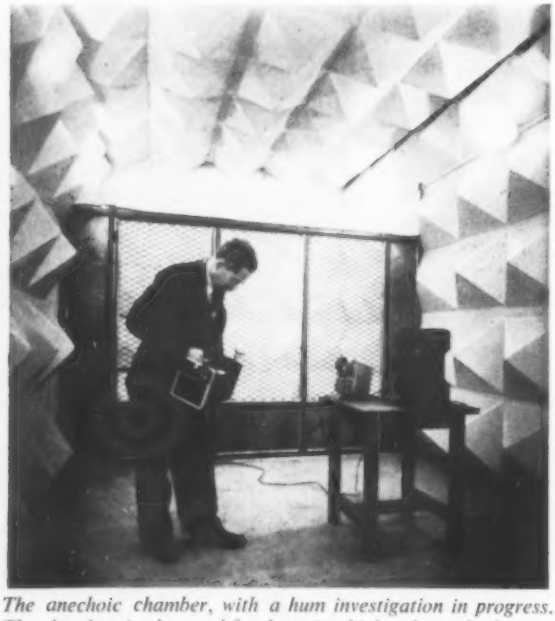
Test Loads

The reactor room, which adjoins the Testing Station and the test cell, houses the a c and d c loads, the 100 000 A 3-phase transformer and the a c and d c distribution link boards.

The a c loads consist of three sets of reactors, each set having a trefoil phase arrangement to equalise mutual inductive effects. Currents from about 50 to 36 000 A in 10 per cent steps are obtainable. Associated resistor banks dissipating a maximum peak power of 2·5 MW are used for power factor adjustment and are provided with forced air ventilation.

Currents for d c testing cover the range 5 to 2 400 A in 10 per cent steps and the resistance loads have a maximum dissipation of 1·8 MW, also with forced air ventilation. Time constants of up to 0·05 can be provided over the whole current range and up to 0·25 over the range 5 to 1 800 A.

The main a c link board provides the routing to the a c loads, the various shunts, the high voltage test transformer, and the 100 000 A transformer. It enables medium voltage a c loads to be inserted in either the input or the output side of the gear under test. The main d c link board is used for shunt selection and the d c circuitry into the test cell has provision for testing either single or double-pole equipment.



The anechoic chamber, with a hum investigation in progress. The chamber is also used for detecting high voltage discharges, both aurally and visually

Test Cell Control Facilities

The control and observation room provides direct viewing into the test cell through windows of ½ in (12.7 mm) thick toughened glass. In the room are a sequence timer and an oscillograph of the Duddell type, with processing room adjoining which enables the oscillograms to be processed and examined a few minutes after the test. The oscillograph has twelve channels and provision is made for three power-measurement channels by the use of alternative vibrators. It also incorporates a drum-type camera designed for quick acceleration up to speeds ranging from 20 to 805 rev/min.

The control desk combines switching controls, exciter and alternator field 'setting up' controls and, for the higher currents, decrement and field boosting adjustments.

Repetitive or single test sequences can be selected, with oscillograph operation if desired; counting of the test sequences is carried out automatically. The test can be stopped at any time from either of two positions by opening the exciter fields and master circuit breaker simultaneously by means of a single switch movement.

Other facilities available are point-of-wave setting for the making switch, operation of the reactor room ventilation motors, and control and distribution of the auxiliary supplies for the gear under test.

Operation of a test initiation handle at the control desk starts the sequence timer which then takes over the test, carrying out automatically the whole test cycle, i.e. the control of the gear being tested, the switching of the alternator output and the operation of the oscillograph and other electrical and photographic devices. Alternative test sequences of 1 or 2 seconds are provided, with single or repetitive testing. In the repetitive case, the interval between each test sequence can be adjusted up to 55 seconds.

The timer consists of fifteen 'making' and fifteen 'breaking' cam-operated switches, each cam of which is individually adjustable, with its position calibrated in terms of time. The whole cam assembly is driven through a magnetic clutch from a synchronous motor and the electrical circuitry of the clutch is designed so that the sequence timer always comes to rest at the correct position for the test sequence to be repeated. Air blast arc extinction is fitted on all the cam switches which break circuit.

The Development Laboratory

This is a notable example of functional design, with carefully-planned provision of every facility required for a wide range of investigations into control gear design and performance.

Obviously, the immediate availability at every working position of a wide variety of electrical supplies is a first essential, and the supply distribution scheme is an outstanding feature of the laboratory.

The main control panel is 26 feet (7.9 m) long and comprises 11 separate sections. The complete structure provides control facilities for 17 separate supplies, with space for future extensions.

Power sources in the generator room are controlled through the main panel and fed via a central distribution board to 25 service points throughout the laboratory. Moreover, each of these points has remote control facilities by plugging a specially designed control box into the supply required. In addition to on/off switching, the control box has two key switches which control the polarity and magnitude of the armature voltage fed to the regulator drive motors in the main control panel. Two-speed continuously variable coarse and fine control of all the generating machines is thus available anywhere in the laboratory area.

High Voltage Testing

High voltage insulation testing up to 120 kV is carried out in a special test area equipped with a ht transformer, an adjustable sphere gap, electronic peak voltmeter, and an inverted Schering bridge for measuring capacitance and power factor of insulating materials and bushings at voltages up to 35 kV rms.

Adjoining the ht test area is the anechoic chamber used primarily for the investigation of noise in control gear operation. A subsidiary purpose of the chamber is to detect high voltage discharges both aurally and visually.

Mention must also be made—albeit briefly—of the standards room and the screened room. In the former is a range of precision dynamometer instruments for ac and dc calibration and reference purposes only, and two basic standards in the form of a vernier potentiometer and a six-decade Wheatstone bridge. Facilities are also available for temperature calibrations at freezing points of various metals and salts, using an electrically-operated pyrometer testing furnace.

The screened room is lined throughout with continuous copper sheet and all incoming supplies are fed through special filters. The room has attenuation characteristics of the order of 80 db. Supply and measurement facilities are available over a range from a few c/s to 200 Mc/s for investigations connected with interference problems, induction of rf currents in power frequency control gear and other work involving rf radiation.

A general view of the development laboratory. The high-voltage test area can be seen in the background to the right of the picture

The main control panel and distribution centre which feeds 25 service points throughout the laboratory

Special facilities for testing marine and traction gear have been provided in the Mechanical Testing Laboratory. In addition to the electrical supplies available throughout the laboratory, there are a 440 V 60 c/s alternator with avr, a 0—220 V dc supply, and two low voltage supplies providing up to 500 A 60 c/s and up to 1 000 A dc respectively.

Mechanical Test Facilities

A shock test machine subjects gear to shock accelerations from a few g to more than 2 000 g, and operating times constant to within ± 15 milliseconds give adequate synchronisation for high-speed cinephotography at speeds up to 8 000 frames a second.

In this laboratory is the vibration table, with a normal maximum loading of 500 lb (226.8 kg) and a frequency range of 0-15 c/s with a peak-to-peak amplitude of 0·1 in (2.54 mm).

Lastly, there is the endurance testing room in which long-term operational tests are performed.

The design and layout of these comprehensive laboratories were largely carried out by the staff of Allen West & Co Ltd, in conjunction with McLellan and Partners who acted as consultants for the power proving plant. Much of the equipment is of Allen West manufacture, but among the principal contractors were A E I (Rugby) Ltd (reactors); Benjamin Electric Ltd (lighting fittings); Brentford Transformers Ltd (special purpose transformers); British Insulated Callender's Cables Ltd (busbars and power cables); Cambridge Instrument Co Ltd (temperature monitoring unit and Duddell oscillograph); Crompton Parkinson Ltd (motor generators, meters, lighting fittings); English Electric Co Ltd (main power test set, power transformers, mercury arc rectifiers, protective relays); Foster Transformers Ltd (oil test and special transformers); A Reyrolle & Co Ltd (master circuit breaker); Westinghouse Brake & Signal Co Ltd (metal rectifiers).

Book Reviews

Electrical Noise. *By Dr D A Bell.* 9¼ × 6½ *in* (235 × 159 *mm*). *Pp x* + 342. *Illustrated. Index.* (*London: D Van Nostrand Co Ltd*, 1960.) Price 50s.

This book is concerned with noise in light current devices and circuits and is not one of prime interest to the power electrical engineer. It is thus for physicists and electronic engineers and, being devoted to fundamentals and physical mechanism, is intended for research workers, particularly those in the fields of telecommunications, television, radar, radio-astronomy and associated branches of electronic science.

The first five chapters cover physical and mathematical fundamentals of the subject with particular reference to Nyquist's theorem, Johnson noise, and shot noise. The next four chapters deal with the theory and cause of noise in a variety of electronic devices such as diodes, amplifiers and masers. There is then a chapter on the inverse-frequency spectrum of current-noise, followed by studies of noise in metal films, rectifiers and transistors; a chapter on radiation detectors; a brief account of Barkhausen noise in ferromagnetics, and a final chapter on standards and measuring techniques. An appendix gives notes on related topics and there are name and subject indexes. Each chapter is concluded with a useful list of references suitable for furthering the study of the relevant subject.

The volume is intended as a unified reference and source book on electrical noise, written with the object of providing a complete guide to all that is now known of the subject, and we are impressed by both the manner in which this has been achieved and by the choice and range of the subjects presented. We give the book a warm welcome and high recommendation.

S AUSTEN STIGANT

Thermodynamics. *By G J Van Wylen.* 9¼ × 6 *in* (235 × 152 *mm*). *Pp xxiii* + 567 *Illustrated. Index.* (*London: Chapman & Hall*, 1959.) Price 64s.

This is a student text book and, apart from the author's stated satisfaction in writing it, its objective is the combination of an approach directed towards students, a rigorous treatment of fundamentals, and a distinctly engineering perspective. In this way the student is given an appreciation and understanding of both the physical and the mathematical aspects of the subject.

There are sixteen chapters and three appendices in the book and briefly they cover the following topics. Chapter 1 is descriptive of actual physical equipment, while chapters 2, 3 and 4 cover basic definitions and concepts. Chapters 5 and 6 deal respectively with the first and the second laws of thermodynamics. Chapter 7 is on entropy—without its often-confusing philosophical smoke screen. Chapters 8 and 9 deal with the ideal gas and with mixtures of ideal gases and vapours respectively. Chapter 10 is concerned with availability and irreversibility.

Chapters 11, 12 and 13 are of a somewhat more practical nature and are concerned respectively with reciprocating machines, power and refrigeration cycles, and flow through nozzles and blade passages. Chapter 14 deals with Maxwell relations, equations of state, and generalised charts; chapter 15 with chemical reactions with emphasis on combustion, introducing the enthalpy of formation and the third law of thermodynamics, while chapter 16 is on equilibrium with emphasis on the chemical equilibrium of ideal-gas mixtures.

The appendices cover the control volume tables of thermodynamic properties, and selected references.

Worked examples are given throughout the text and each chapter is concluded with a range of problems, the answers to a third of these being given at the end of the book.

The author has done his students great service by writing this book, which is a pattern of clear exposition and experienced understanding selection of material. It would in fact be difficult for an earnest student not to find himself well versed in thermodynamic fundamentals after having read the book and applied himself thoughtfully to its contents. The author is Professor of Mechanical Engineering at the University of Michigan. The production of the book is unexcelled in all respects.

SAS

Electrical Machines (Direct and Alternating Current). *By Charles S Siskind.* 9¼ × 6 *in* (235 × 152 *mm*). *Pp ix* + 563. *Illustrated. Index.* (*London: McGraw Hill*, 1959.) Price 62s 6d.

A review of the first edition of this basic but practical textbook on electrical machines was published in the December, 1950 issue of THE BEAMA JOURNAL.* The need so soon for a new edition clearly demonstrates that an author will find a ready market for any book which presents a subject in a manner suitable for the non-specialist reader.

This new edition comprises twelve chapters and two appendices, and is illustrated by 345 line diagrams. The text has been re-worded, modified and rewritten where necessary to clarify the statements of the principles and practices of energy-conversion equipment. A complete new chapter on rectifiers has been added which includes converters, semi-conductor, valve and arc devices.

The author has provided 828 questions and 298 problems for student assignment and self study. Answers to the problems are given at the end of the book. Although many of the questions are of a trivial nature, this is necessary for the type of student for whom the book is mainly written.

This is a very readable book which provides a broad survey in sufficient detail for a first study of the subject. The treatment is adequate for the requirements of most non-electrical students, and will also be of use in the instruction of electrical technicians. This class of student does not require a thorough-going mathematical treatment.

P F SOPER

Progress In Dielectrics. *Volume* 2. *By J B Birks & J H Schulman.* 10 × 6¾ *in* (254 × 171 *mm*). *Pp vii* + 225. *Illustrated. Index.* (*London: Heywood & Co Ltd*, 1960.) Price 55s net.

This is the second of what is to be an annual volume on dielectrics, and it contains six surveys of dielectric properties in weak electric fields. The aspects covered are an introductory survey to a very large and complex subject—the theory of polarisation and absorption in dielectrics. This is followed by a systematic examination of the dielectric properties of polymeric systems, a subject that is of considerable importance because it includes a number of the common plastic materials.

Irradiated high polymers—a relatively new subject and one that must have many future ramifications—is surveyed by two well known workers in the field: Black and Charlesby, and the present position is clearly explained.

The next two articles are of exceptional importance. They deal respectively with the dielectric properties of glass, and the complex subject of high-permittivity ceramics for capacitors. Both are extremely good articles.

The final article deals with artificial dielectrics, where conductive elements, suitably spaced, take on the character of dielectrics at very high frequencies. This subject is only of interest to certain workers in microwave radio, but the article forms a very good survey of the field.

JHJ

Exploding Wires. *By William G Chace & Howard K Moore.* 9¼ × 6½ *in* (235 × 159 *mm*). *Pp ii* + 373. *Illustrated.* (*London: Chapman & Hall*, 1959.) Price 76s net.

In April 1959 a Conference on the Exploding Wire Phenomenon was held by the Geophysics Research Directorate, Air Force Cambridge Research Centre in Boston, Massachusetts, USA with the co-operation of the Lowell Technological Institute Research Foundation, and this volume is a record of the papers presented on that occasion.The book is intended to serve as a monograph on the subject, since nowhere has there previously appeared any other book on electrical wire explosions.

The studies relate mostly to the so-called fine wires (eg fuse wires, resistance wires) and not to that phenomenon so beloved by the lay press: 'the fusing of an electric cable'.

The papers fall into three groups which are given as theoretical and experimental, shock waves, and applications and technique. Respectively the groups contain 13, 4 and 8 papers, these being preceded by an introductory chapter giving a brief survey of exploding wire research.

Basically, the experimental test circuit is simple, consisting of a capacitor which is charged from an exciting source through a

* THE BEAMA JOURNAL, **57**, No 162, p 393.

resistor and which discharges through the test wire via a triggered spark gap or equivalent device. Wires of various diameters and materials have been investigated and the papers record a wide range of the electrical, physical, thermal and radiation phenomena associated with exploding wires. Particular mention may be made of the studies of shock waves and of the use of the emitted light for photographic purposes.

The book is a well prepared account of high-level research carried out on a subject that is as yet but little understood, and accordingly it is of considerable importance to all those investigators who are active in its field. It is of interest also to those electrical engineers who are concerned with the behaviour of fuses.

The volume is well illustrated by graphs, oscillograms, photographs of apparatus, high-speed photographs of exploding wire phenomena, and line drawings, all of which add to the value of the work.

S A S

Servomechanisms and Regulating System Design. *Vol 1. 2nd edition. By H Chestnut and R W Mayer.* $9\frac{1}{4} \times 6\frac{1}{4}$ *in* (235 × 159 *mm*). *Pp xvii* + 680. *Illustrated. Index.* (*London: Chapman & Hall; New York: Wiley*, 1959.) Price 94s net.

The first edition of this book has long been regarded as one of the classics in its field, so that the appearance of a new edition creates much interest in the consequent changes of text. The main additional material is contained in two chapters, one on the root-locus method, and the second on the use of an analogue computer for the solution of control system problems. Other features include a new account of error coefficients, revision of nomenclature and definitions in accordance with current American practice, and additional material on relating open-loop frequency response to approximate closed-loop transient response.

It should be borne in mind that this volume has been adapted to the needs of engineers and engineering students who have not had previous training or experience in the field of closed-loop systems. To this end the comparative simplicity of the mathematics employed is an advantage (although perhaps not appealing to those more mathematically minded), while the inclusion of the additional chapters is essential when viewed in relation to modern practice.

Overall, this is an outstanding book that will continue to be used and valued for training and for general reference purposes.

H GOLDENBERG

Electrical Engineering (Theory and Practice). *By W H Erickson & N H Bryant.* $9\frac{1}{4} \times 6$ *in* (235 × 152 *mm*). *Pp xiii* + 614. *Illustrated. Index.* (*London: Chapman & Hall*, 1959.) Price 64s net.

The first edition of this book, which presents a broad treatment of the theory and practice of electrical engineering, was reviewed in our issue of January, 1953.* This new edition comprises twenty-nine chapters and is illustrated with 476 line diagrams. The author has increased the number of problems to be solved by the reader to 410, with answers at the end of each numerical question.

The electronics section has been extensively reorganised to give an equal treatment both to valves and semi-conductor devices. Wherever possible the same methods of analysis are used for circuits incorporating either type of these devices.

In addition to these changes, the author has also included a simple introduction to the principles of the magnetic amplifier.

The text is so prepared that only the bare minimum of mathematical symbology is employed. In consequence the book is easily read and provides an excellent introduction to the technology of electrical engineering. With the ever-increasing use of electrical equipment, more and more books like this will be needed, especially for the non-specialist engineer. The treatment is also of the type suitable for the use of this book in courses for electrical technicians.

The treatment of the subject matter, as well as the selection of the chosen topics, give the book a modern appearance so often lacking in all but the best revised editions. The author has wisely concentrated on fundamentals and ignored practical constructional features, except where these are necessary for an understanding of the theory.

P F SOPER

* THE BEAMA JOURNAL, **60,** No 187, p 34.

FBI Register of British Manufacturers—1960. $9\frac{1}{2} \times 7\frac{1}{2}$ *in* (241 × 191 *mm*). *Pp* 1 164. (*London: Kelly's Directories Ltd*, 1960.) Price 42s net.

This new edition contains the names and addresses of all the members of the Federation of British Industries, together with their products and services which are listed under 5 400 headings.

Other sections give information on trade associations affiliated to the FBI; trade names, and trade marks. The language glossaries have been designed to give easy cross-reference between the headings in the classified Buyers' Guide and the French, German and Spanish translations.

Wireless and Electrical Trader Year Book. $8\frac{1}{2} \times 5\frac{3}{4}$ *in* (223 × 146 *mm*). *Pp* 448. (*London: Trader Publishing Co Ltd*, 1960.) Price 15s net.

This year book, which is now in its 31st edition, covers the same range of useful information which has been included in past editions, but of course revised and brought up to date.

A new feature consists of short reviews of some 170 technical books of interest to those connected with the radio and television industry. This year book is now regarded as a standard guide and is of considerable assistance to overseas buyers in finding British sources of supply.

Electricity Undertakings of the World. $8\frac{3}{4} \times 6\frac{1}{4}$ *in* (223 × 159 *mm*). *Pp* 648. (*London: Benn Brothers Ltd*, 1959-60.) Price 30s net.

Known generally as 'The Red Book', this year book is claimed to be the only reference work of its kind to attempt a world-wide coverage of electricity supply information. There are three main sections. The first deals with undertakings in the United Kingdom and includes information on power stations, bulk supply tariffs, distribution details and a directory and 'Who's Who' of the Electricity Council, the Central Electricity Generating Board and the Area Boards.

The names of supply authorities in the British Commonwealth together with details of generation, transmission and supply are given in the next section. New entries since the last edition are those for Ascension Island and Christmas Island and there is also additional information on India, Pakistan and South Africa.

The next section gives similar details for countries outside the Commonwealth and now includes further details on Costa Rica and Poland.

SHORTER BOOK REVIEWS

The Properties, Physics and Design of Semiconductor Devices. *By J N Shive.* $9\frac{1}{4} \times 6\frac{1}{2}$ *in* (235 × 115 *mm*). *Pp* 488. (*New York and London: D Van Nostrand & Co*, 1959.) Price 73s net.

This work provides a comprehensive physical theory of semiconductor devices. It includes thermistors, transistors, varistors and photoelectric cells.

Mathematical Programming and Electrical Networks. *By J B Dennis.* $9\frac{1}{4} \times 6$ *in* (235 × 152 *mm*). *Pp vi* + 186. *Illustrated.* (*New York: John Wiley; London: Chapman & Hall*, 1959.) Price 36s net.

A new approach to mathematical programming based on analogy with electrical networks is the subject of this research monograph.

Digest of Literature on Dielectrics: Vol 22. *Edited by R A Soderman & L J Frisco.* $10\frac{1}{2} \times 8\frac{1}{2}$ *in* (267 × 216 *mm*). *Pp xiii* + 293. *Illustrated.* (*Washington: National Academy of Science*, 1959.) Price $5.

This digest is the work of the Conference on Electrical Insulation which is sponsored by the National Academy of Sciences.

Semiconductor Abstracts: Vol IV. *Edited by E Paskell.* $11\frac{1}{4} \times 8\frac{1}{4}$ *in* (286 × 210 *mm*). *Pp. 456.* (*New York: John Wiley; London: Chapman & Hall*, 1959.) Price 96s net.

These abstracts have been compiled by the Solid State Devices Division of the Electrochemical Society of the Battelle Memorial Institute.

Economic Circuit Theory. *By H J Zimmermann and S J Mason.* $9\frac{1}{4} \times 6$ *in* (235 × 152 *mm*). *Pp xvii* + 504. *Illustrated.* (*New York: John Wiley; London: Chapman & Hall*, 1959.) Price 86s net.

Deals mainly with methods of analysis of electronic circuits.

Masers. *By J R Singer.* $9\frac{1}{4} \times 6$ *in* (235 × 152 *mm*). *Pp xi* + 147. *Illustrated.* (*New York: John Wiley; London: Chapman & Hall*, 1959.) Price 52s net.

Provides a unified description of microwave amplifiers operating on the induced emission principle.

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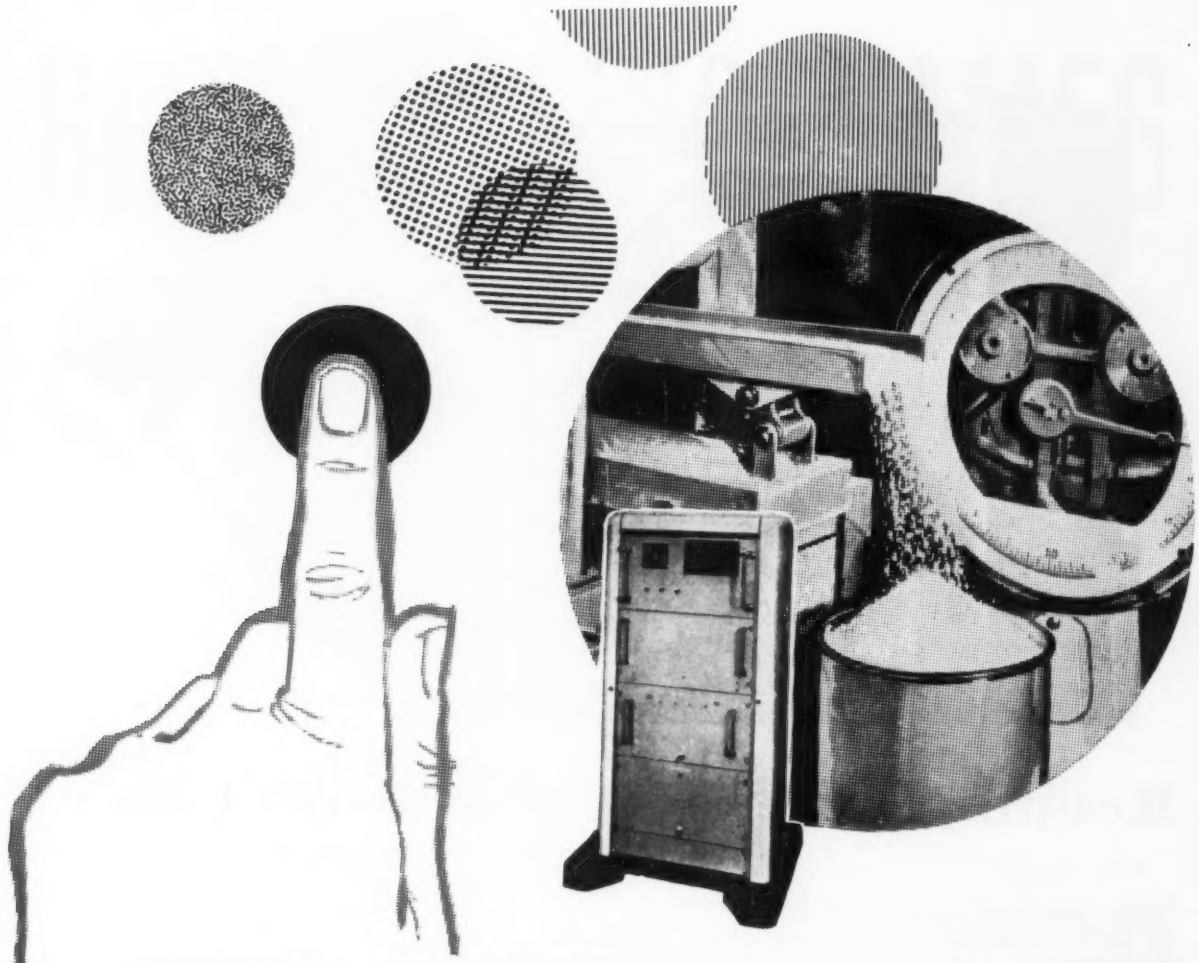

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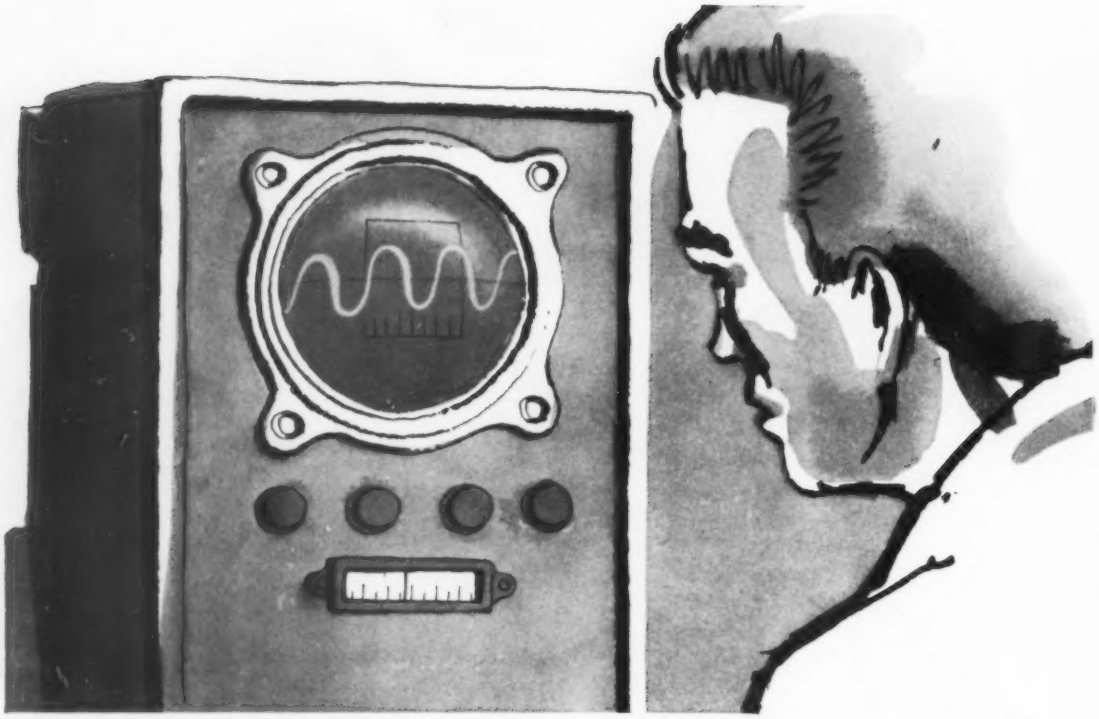

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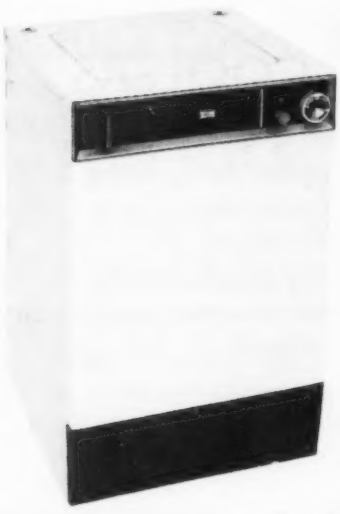

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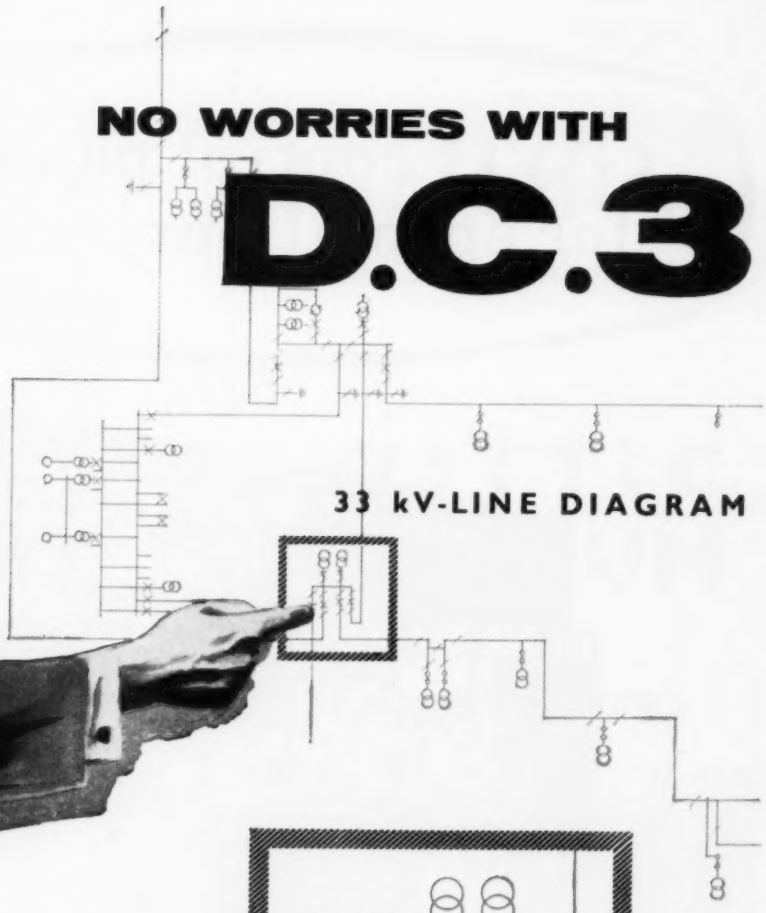

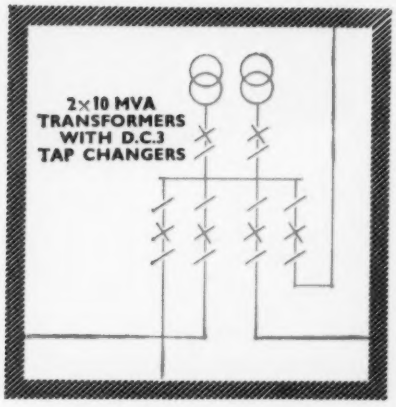

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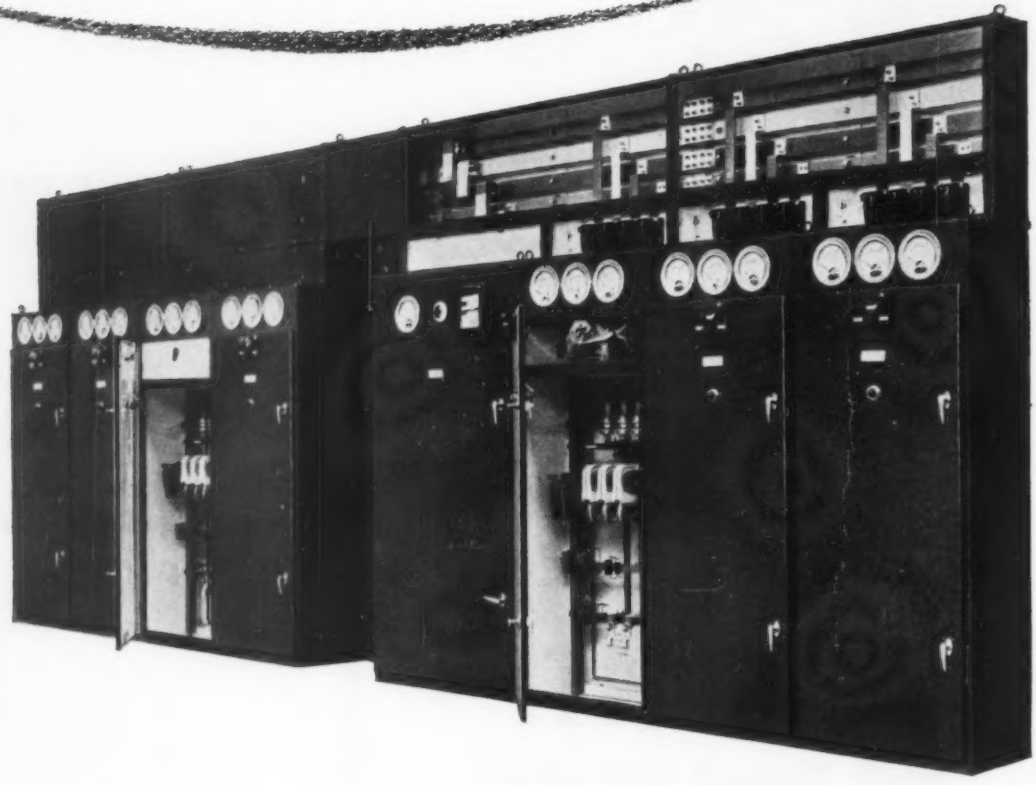

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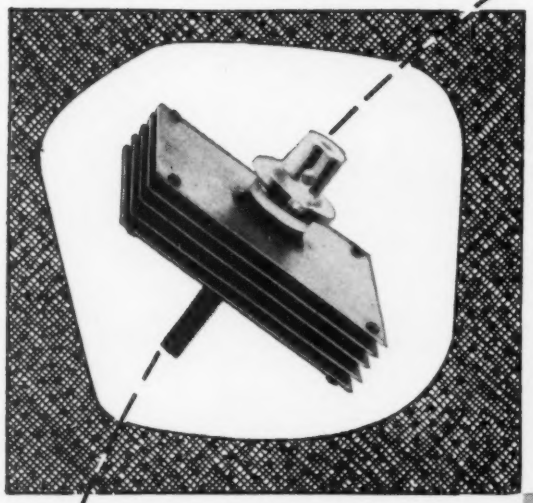

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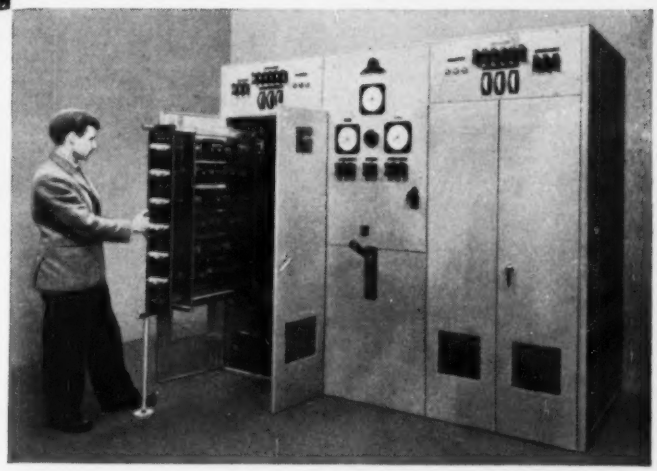

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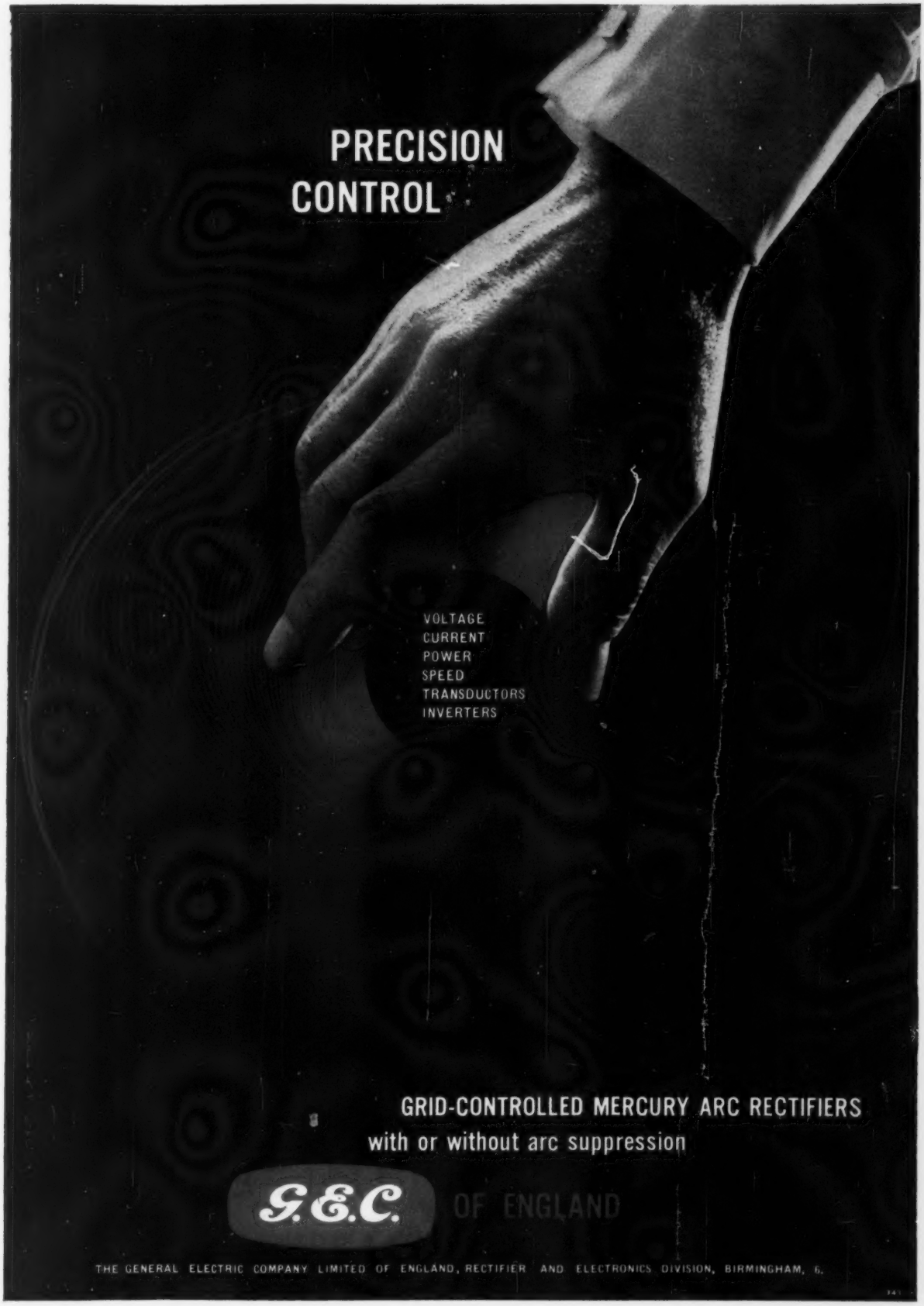
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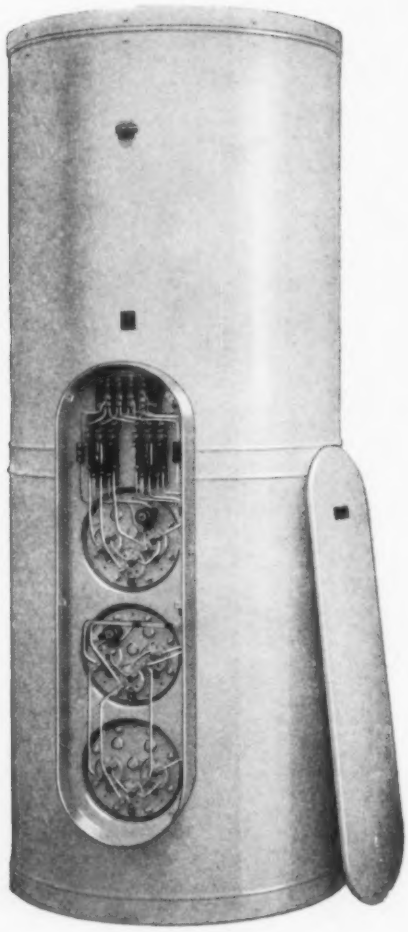

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Henley Series 3 Service Fuses are the ideal solution to the present day problem of ever-increasing loads. 60 amp service fuses installed today can be easily converted to 100 amp when the load demands by the use of a Series 3-100 conversion set (comprising 100 amp carrier, turret etc.) together with a suitable fuse-link.

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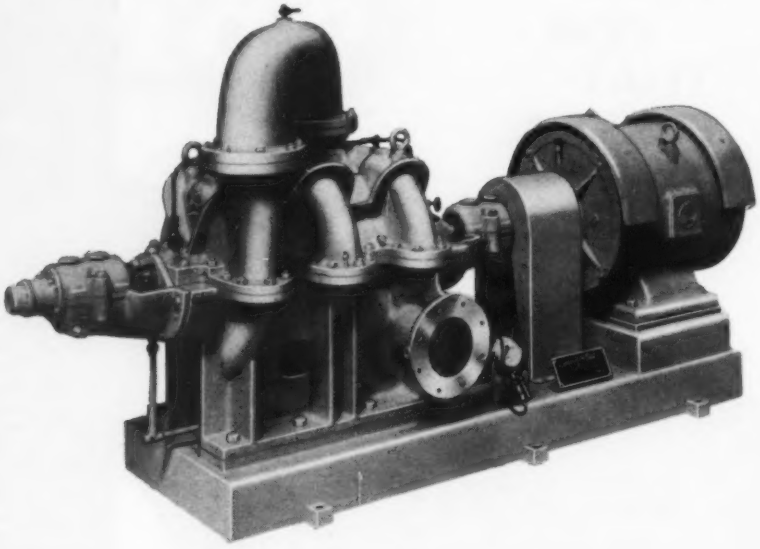
Three-Stage Condensate Extraction Pump for Mirrlees Surface Condensing Plants.



THE MIRRLEES WATSON CO LTD

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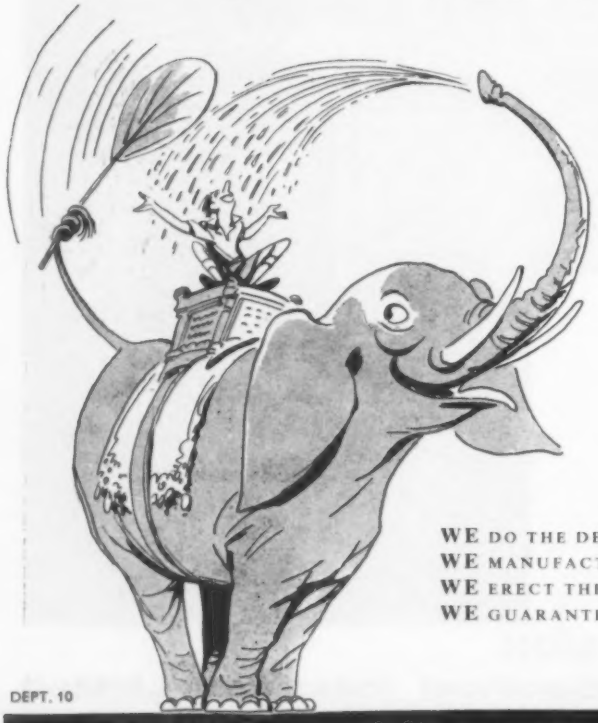
When it's a Question of Cooling . . .



Undoubtedly, the answer to all air and hydrogen cooling problems is PREMIER. PREMIER closed circuit coolers, among the most highly efficient and economical in the world, are installed in such important power stations as Meaford, Poole, Uskmouth, Hams Hall 'C', Darlington, Bold 'B', Stockport and Johannesburg; and hydrogen coolers and heat exchangers are in hand for Hunterston Atomic Power Station. PREMIER design and erect the plants, guarantee the performance and give a 100% after-sales service. PREMIER Coolers are known and acclaimed by engineers everywhere.

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WE DO THE DESIGNING OURSELVES
WE MANUFACTURE OUR OWN PLANTS
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WE GUARANTEE THE PERFORMANCE

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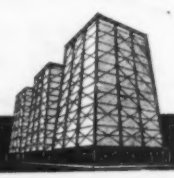

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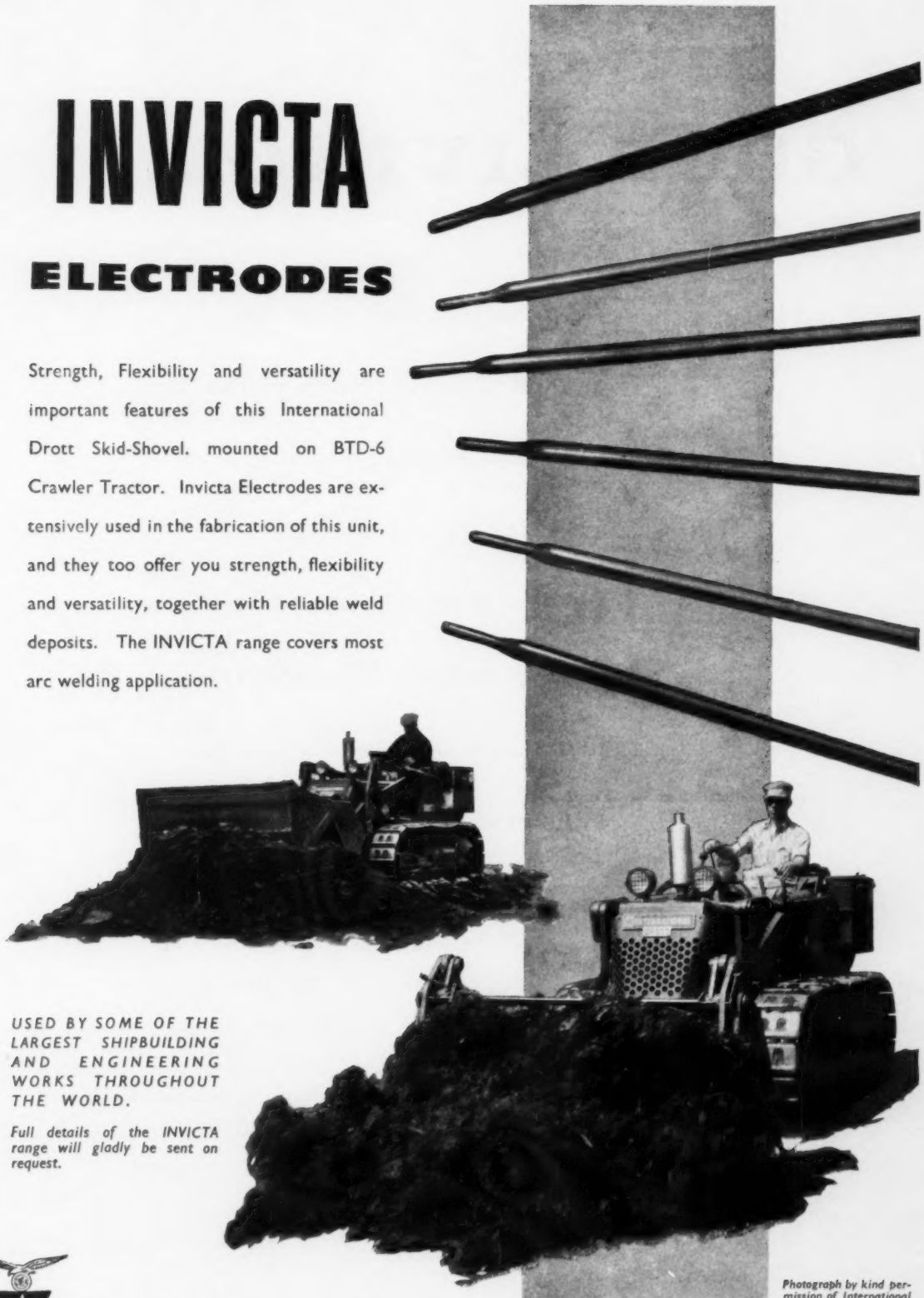
Strength, Flexibility and versatility are important features of this International Drott Skid-Shovel. mounted on BTD-6 Crawler Tractor. Invicta Electrodes are extensively used in the fabrication of this unit, and they too offer you strength, flexibility and versatility, together with reliable weld deposits. The INVICTA range covers most arc welding application.



USED BY SOME OF THE LARGEST SHIPBUILDING AND ENGINEERING WORKS THROUGHOUT THE WORLD.

Full details of the INVICTA range will gladly be sent on request.

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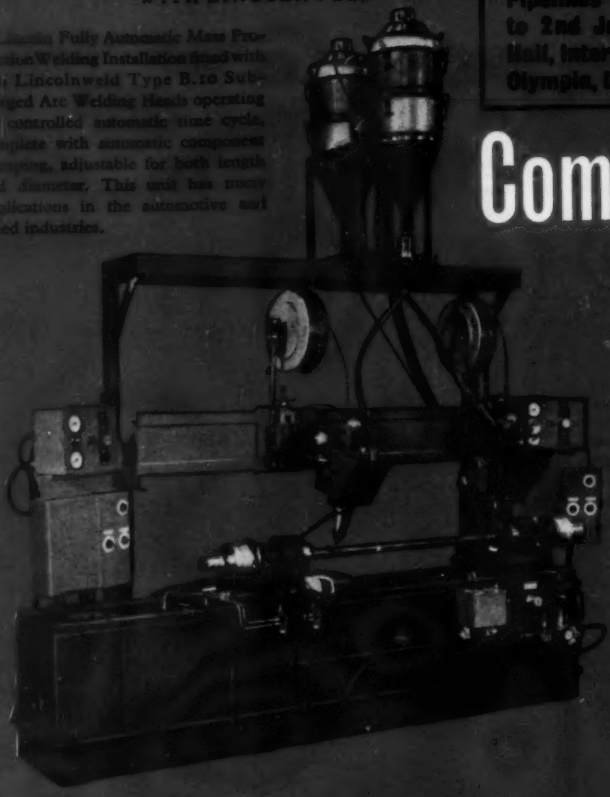
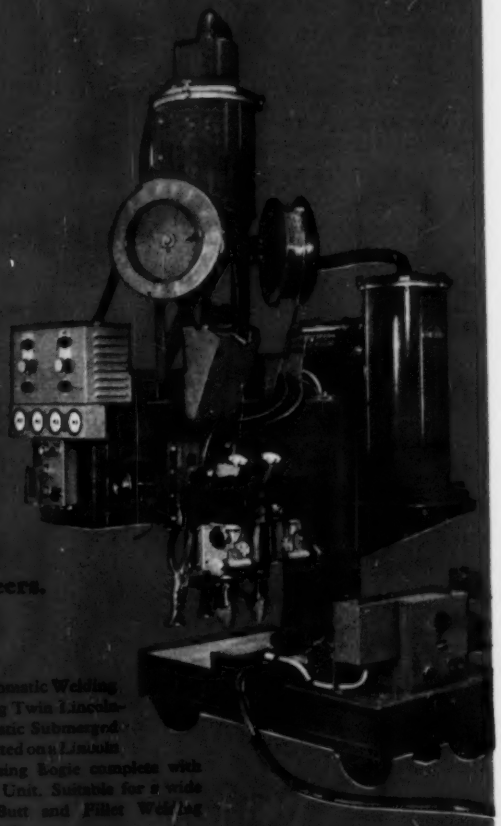
A Lincoln Fully Automatic Mass Production Welding Installation fitted with twin Lincolnweld Type B.10 Submerged Arc Welding Heads operating on controlled automatic time cycle, complete with automatic component clamping, adjustable for both length and diameter. This unit has many applications in the automotive and allied industries.



SEE US on Stand No. 1, 1st International Pipes and Pipelines Exhibition, Earls Court, London, 30th May to 2nd June, and on Stand No. 3, Grand Hall, International Machine Tool Exhibition, Olympia, London, 25th June to 8th July.

Complete welding installations by LINCOLN



Sooner or later **YOU** will become interested in Submerged Arc Welding.

LINCOLN have a *complete* range of Submerged Arc Welding Equipment **PLUS**

★ **Hundreds of successful installations.**

★ **Years of knowledge acquired throughout the world.**

★ **A fully trained staff of Design and Welding Engineers.**

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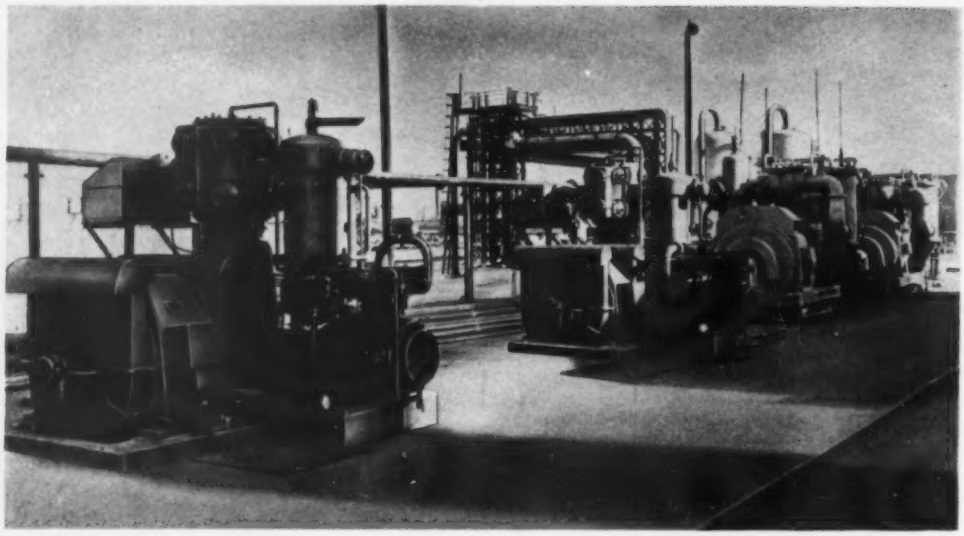
AC & DC electric motors

play a significant part in modern industry.



Mather & Platt induction motors working in the open air and driving compressors at a large chemical works.

The two in the foreground are squirrel-cage motors rated at 3,300 volts, 350 b.h.p., 333/325 r.p.m. The two in the background are of similar type rated at 3,300 volts, 325 r.p.m., 435 b.h.p.

These four drip-proof, weather-proof motors are direct on started, taking low starting current.

Mather & Platt LIMITED

Mather & Platt Ltd., Park Works, Manchester, 10.

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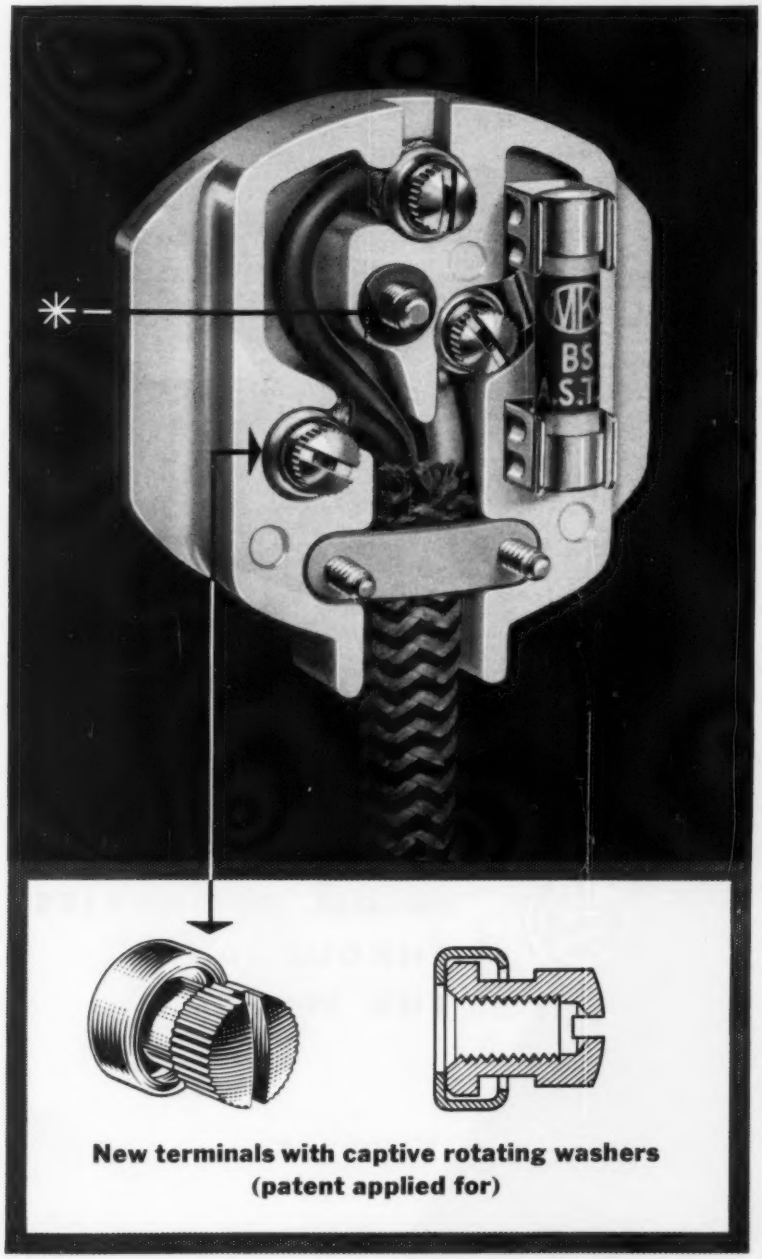
A. 41

FURTHER ADVANCES IN 13 AMP. PLUG DESIGN



New terminals with captive rotating washers (patent applied for)

MK 179E DHB

(BS1363)

New terminals with captive rotating washers! A tremendous advance—speeds wiring and ensures that washers are not lost or forgotten.

***Cover screw now captive with the plug body cannot be lost and saves handling time. "Shakeproof" spring washer (also captive with the screw) ensures a firm and non-loosening fixing.**

* * * *

Extended finger shields give maximum protection for the fingers whilst providing a firm and natural grip.

"One Piece" plug pins and terminals permanently secured to the plug body. Stranded conductors easily and quickly wrapped around non-rotating terminal studs. A secure and efficient connection without the danger of cutting the conductors as likely with some "Pinching Screw" type terminals.

The M.K. Cartridge Fuse-Link (ASTA certificate of rating has been obtained) is secured in integral silver-plated contact clips for minimum contact resistance and low temperature rise. Enclosed within the plug for absolute safety yet quickly replaced by a twist of the captive cover securing screw.

Plug cover and body are track-resisting mouldings.

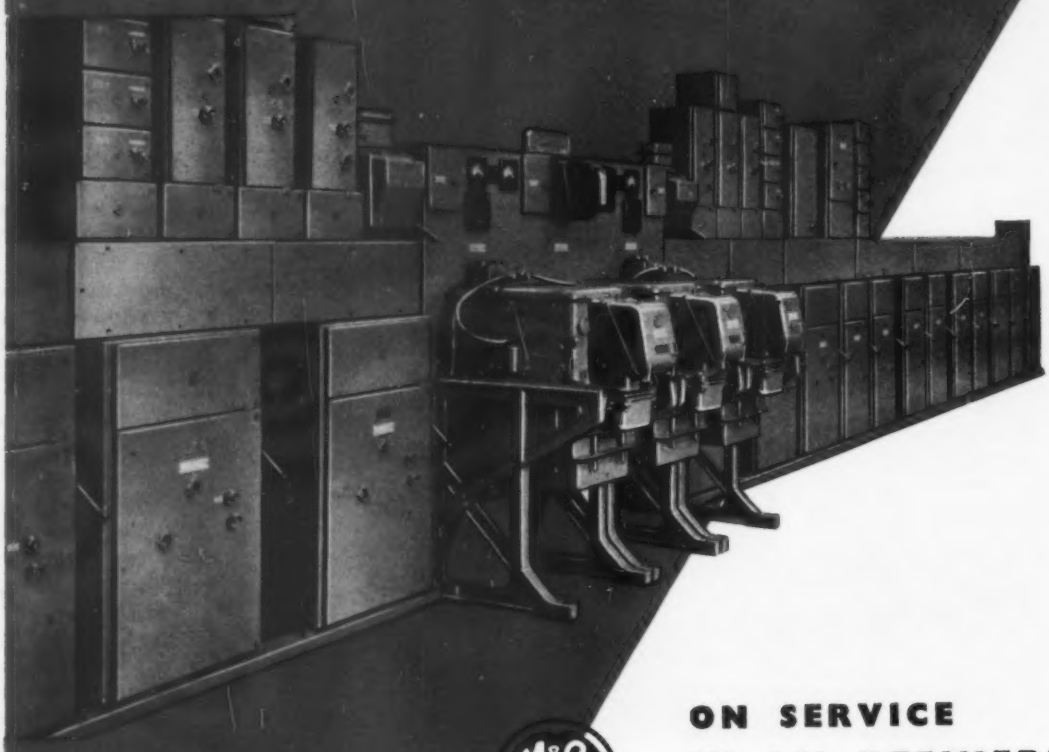
FOR LEADERSHIP IN 13 AMP. PLUG DESIGN

MK

Send for leaflet 255

M.K. ELECTRIC LTD., SHRUBBERY RD., EDMONTON, LONDON N.9 ENGLAND

Unit Type Motor Starters



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Busbar section switches up to 2,000 amps.

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Starting and Stopping under Control

INTEGRAL A.C. MOTOR UNITS
CLUTCH/BRAKE ACTUATED BY ROTOR THRUST
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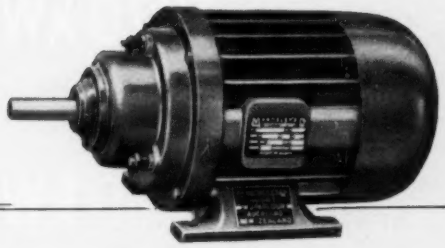

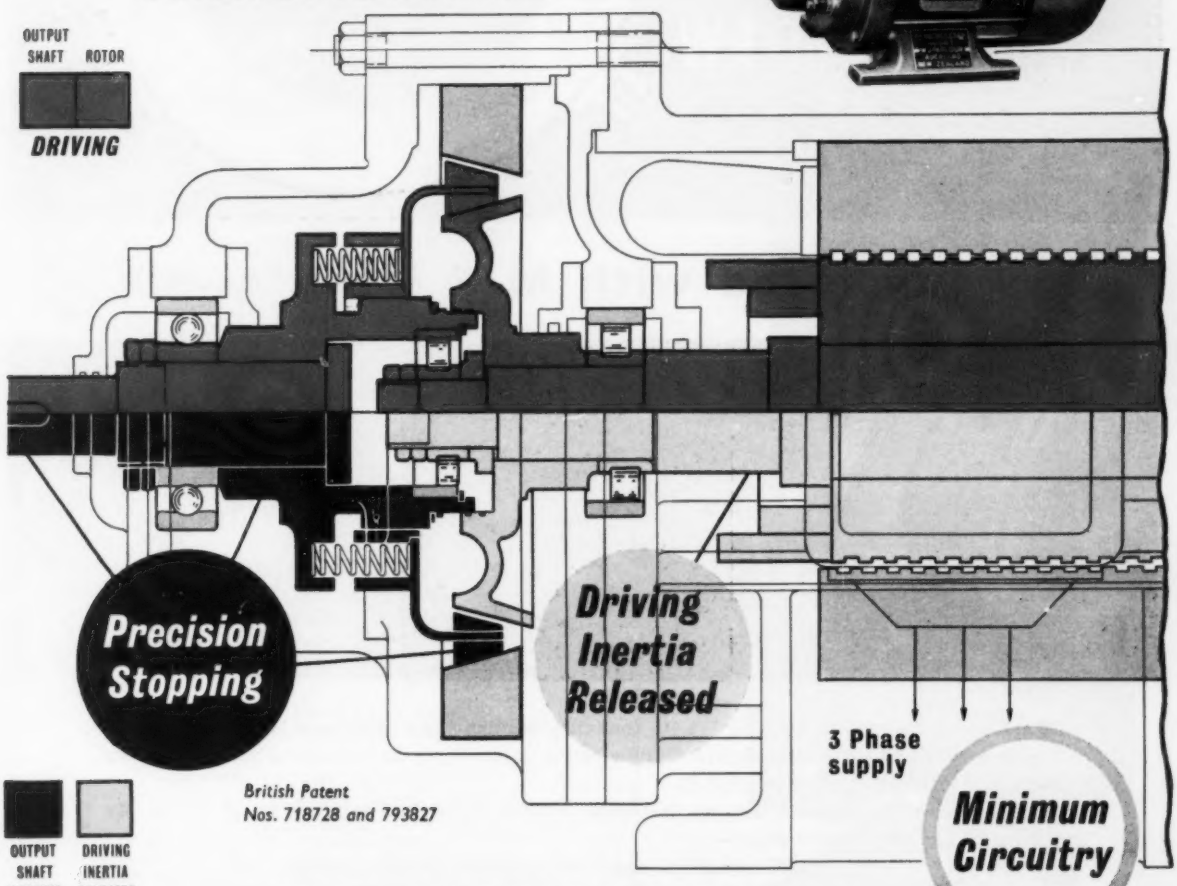

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- **Foot or Flange Fixing; available for mounting at any predetermined angle from horizontal**

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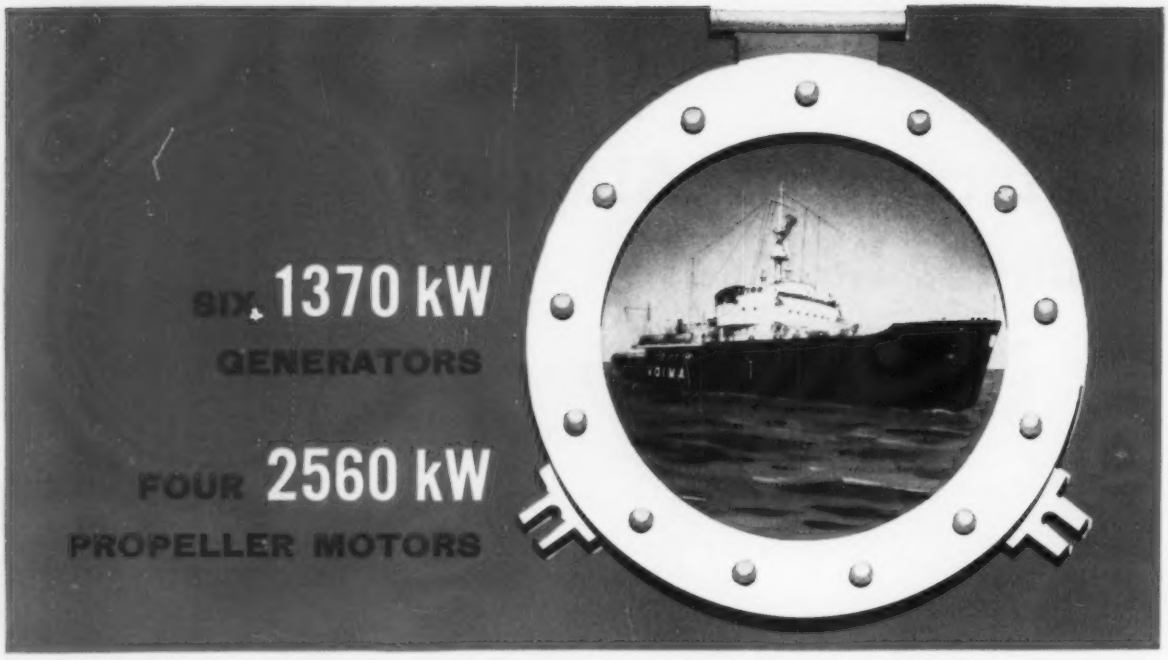


all insulated with M & I materials

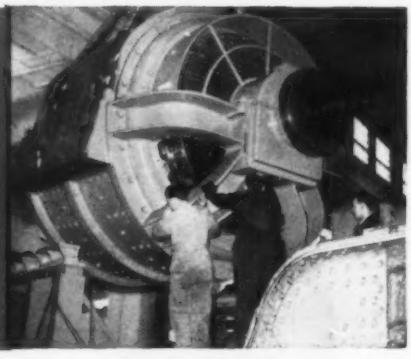
A stator is winding the rotor of one of the six 1,370 kW generators.

Loading one of the propeller motors on to a railway truck for transport to the shipyard.

Photographs by courtesy of :—

OY STRÖMBERG AB manufacturers of the main and auxiliary electrical machinery.

WÄRTSILÄ - KONCERNEN AB who built the "Voima".



The Finnish icebreaker "Voima" (4,415 tons displacement) has propellers both fore and aft. She is powered by six direct-coupled diesel-electric units supplying current to her four driving motors, which can develop 10,500 H.P.

These are the electrical insulating materials manufactured and supplied by M & I for the "Voima" and three sister ships :—

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MOULDING MICANITE for commutator rings, etc · WOVEN GLASS TAPE ·
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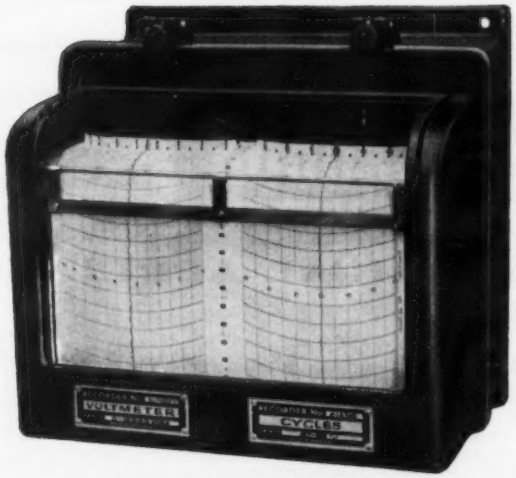

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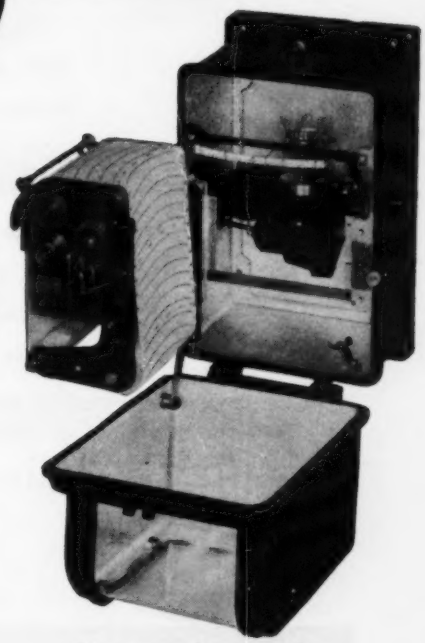

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OF DOMESTIC ELECTRICAL APPLIANCES

During recent years the demand for electrical appliances has multiplied to a huge extent—creating, in the process, a wide and exhaustive product range specially geared to meet the needs of the modern householder.

Morphy-Richards have kept pace with this development until today their range of electrical appliances—embracing everything from hairdryers to spin dryers, from fires to refrigerators, is by far the widest produced in the United Kingdom.

Every Morphy-Richards appliance is designed to meet both the immediate needs of the consumer and the demands of the future. This is why special attention has always been paid to meticulous design, careful workmanship and top-quality engineering without raising the price to unrealistic heights. This is why Morphy-Richards hold such a proud position in a fiercely competitive world.

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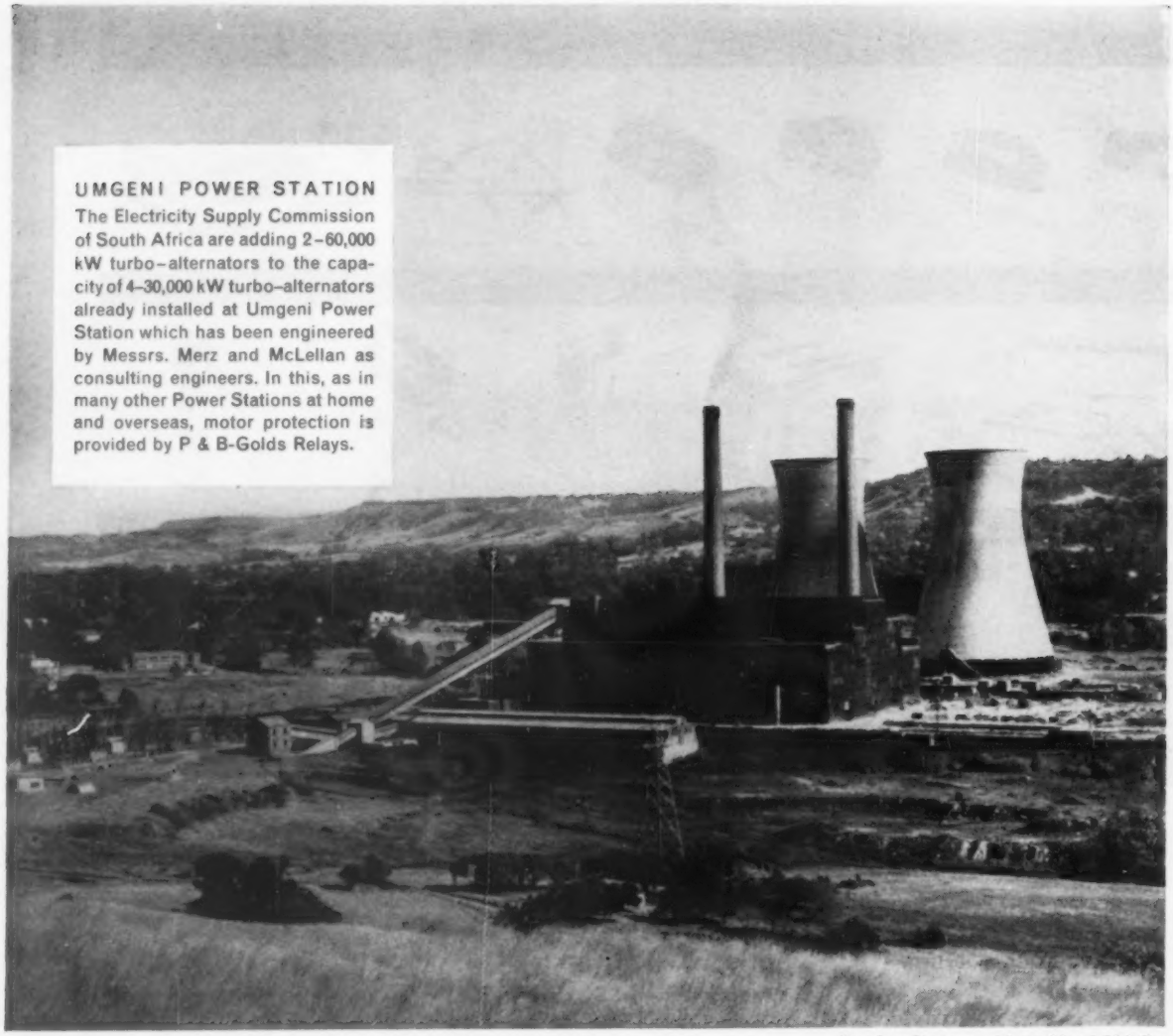


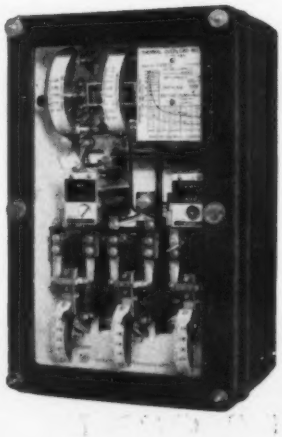
UMGENI POWER STATION

The Electricity Supply Commission of South Africa are adding 2–60,000 kW turbo–alternators to the capacity of 4–30,000 kW turbo–alternators already installed at Umgeni Power Station which has been engineered by Messrs. Merz and McLellan as consulting engineers. In this, as in many other Power Stations at home and overseas, motor protection is provided by P & B-Golds Relays.

Consulting Engineers — Messrs. Merz & McLellan

THE ELECTRICITY SUPPLY COMMISSION choose P&B Golds Relays

P & B Relays give full protection for motors with any starting periods or currents under extremes of ambient temperature.
P & B Golds Relays protect against phase failure, overload, short circuit or earth fault.
P & B Stalling Relays give complete protection against stalling under all conditions. Send for current literature.



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THE P & B ENGINEERING CO. LTD
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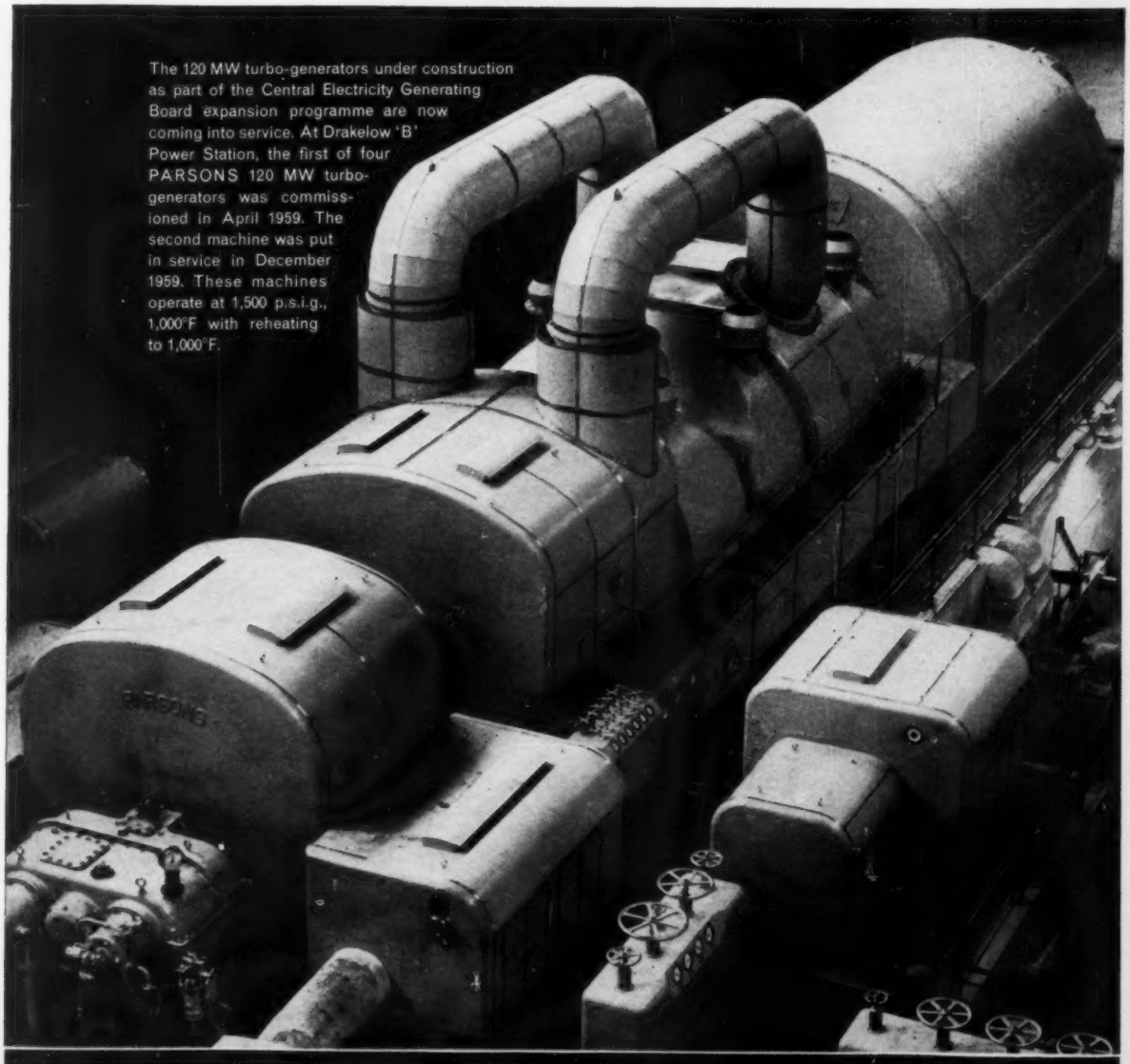
POWER ....another "120 MW" now generating



The 120 MW turbo-generators under construction as part of the Central Electricity Generating Board expansion programme are now coming into service. At Drakelow 'B' Power Station, the first of four PARSONS 120 MW turbo-generators was commissioned in April 1959. The second machine was put in service in December 1959. These machines operate at 1,500 p.s.i.g., 1,000°F with reheating to 1,000°F.

PARSONS

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BRITAIN'S TOP SELLING ELECTRIC COOKERS

One of the greatest success stories in the domestic appliance industry has been the rapid increase in sales of TRICITY *electric cookers. This has been particularly marked over the last few years—as* TRICITY *introduced one new design idea after another—and culminated in the introduction of the revolutionary new Tricity* MARQUIS *and* VISCOUNT, *which are currently Britain's biggest-selling electric cookers.*

TRICITY MARQUIS (illustrated)

4 high-speed radiant plates · pull-out spill tray · separate full width grill · huge quick-heat oven · inner glass door · spacious hot cupboard · ovenlight · simmer controls to all plates · auto-time control · minute timer · finger-light eye level controls · hoblight · storage drawer

TRICITY VISCOUNT

3 high-speed radiant plates · pull-out spill tray · separate full width grill · huge quick-heat oven · inner glass door · finger-light eye level controls · interchangeable coloured fascia panels · spacious hot cupboard · simmer control to all plates · wired for auto-time control

Also in the latest TRICITY range are the 'Popular', a low-cost compact cooker, and the new Built-in Cooker Units for fitted kitchen furniture.

TRICITY PIONEERED ELECTRIC COOKING NEARLY SIXTY YEARS AGO

TRADE ENQUIRIES TO: TRICITY COOKERS LIMITED · A SUBSIDIARY COMPANY OF THORN ELECTRICAL INDUSTRIES LIMITED · THORN HOUSE · UPPER ST. MARTIN'S LANE · LONDON WC2 · ENGLAND

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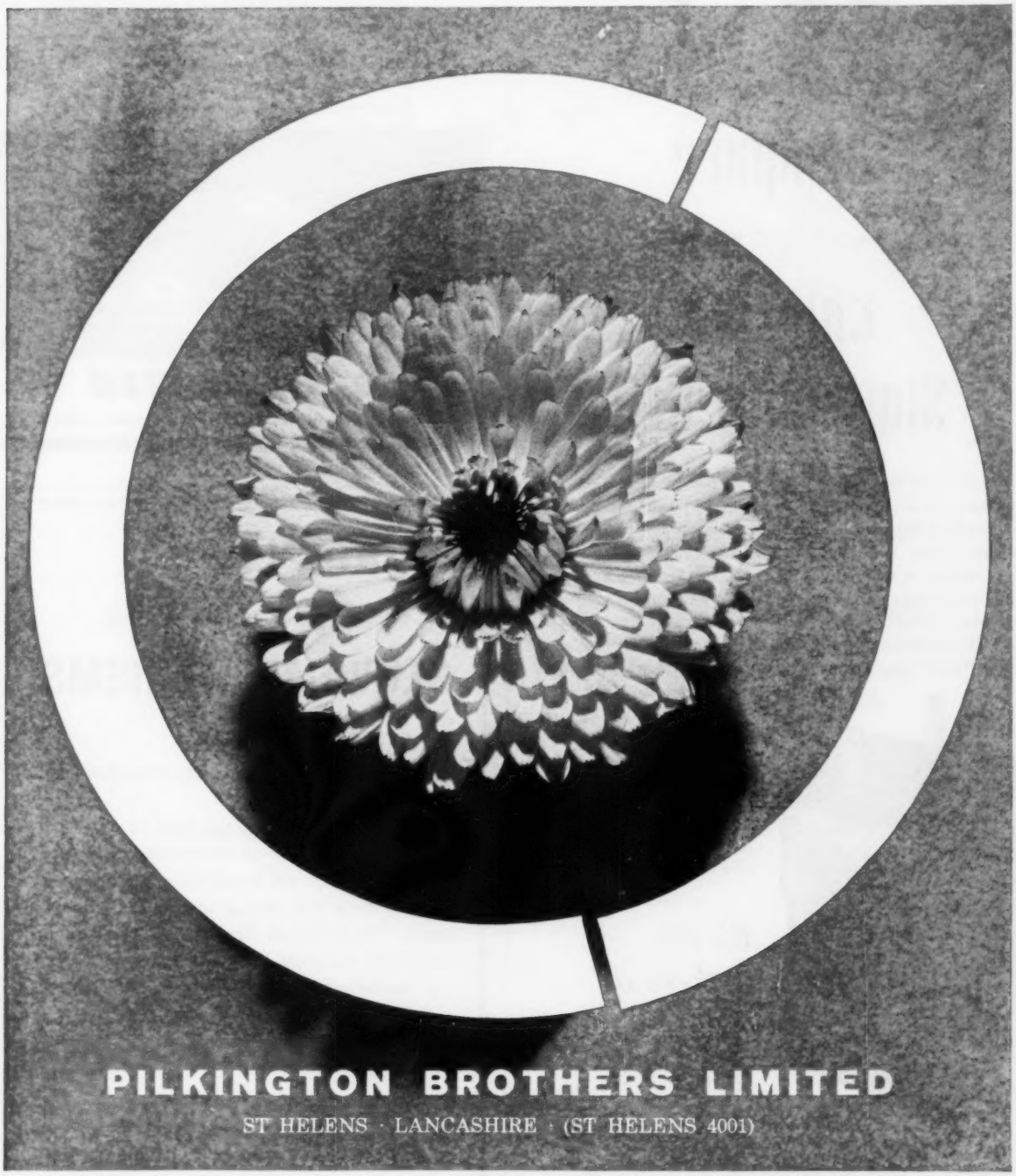

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3 high-speed radiant plates · pull-out spill tray separate full width grill · huge quick-heat oven inner glass door · finger-light eye level controls interchangeable coloured fascia panels · spacious hot cupboard · simmer control to all plates wired for auto-time control

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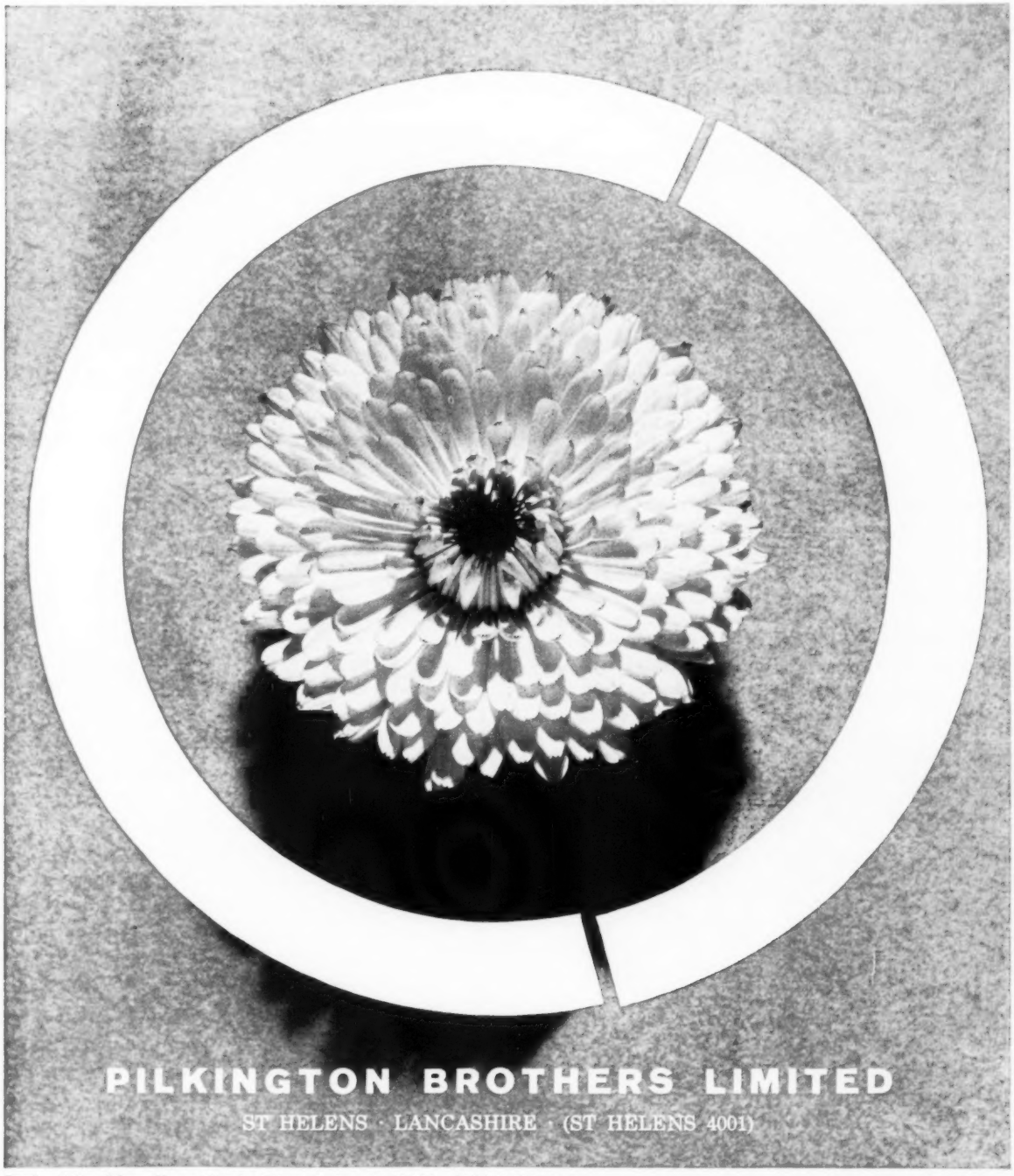

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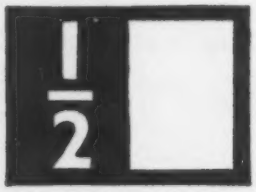

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FROM THE **NEW**

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This new cell is specially designed for standby duties entailing discharge rates between, say, the 3-hour and the very high rates demanded for switch-closing purposes. With its Planté positive and pasted negative plates, Porvic microporous separators and many other improvements in material and in design, this light, robust cell will perform its duties with greater efficiency, with complete reliability and with a saving in battery space of approximately 50%. It is ideal for trickle-charge operation* and has all the remarkable length of life of the Planté type of construction. In Great Britain today standby batteries occupy millions of cubic feet of valuable space. The new Chloride cell could free almost half of it.

** The new cell will from now onwards be fitted in all Keepalite units—the Chloride Company's automatic emergency lighting system.*

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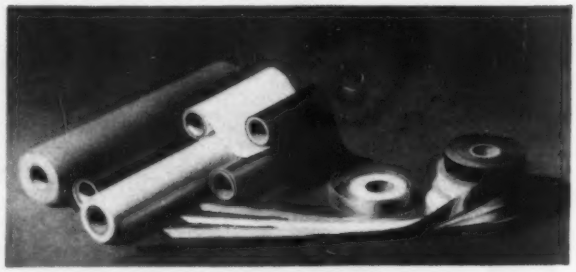

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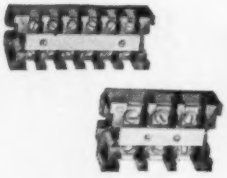

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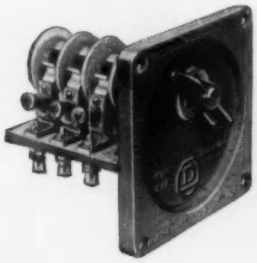

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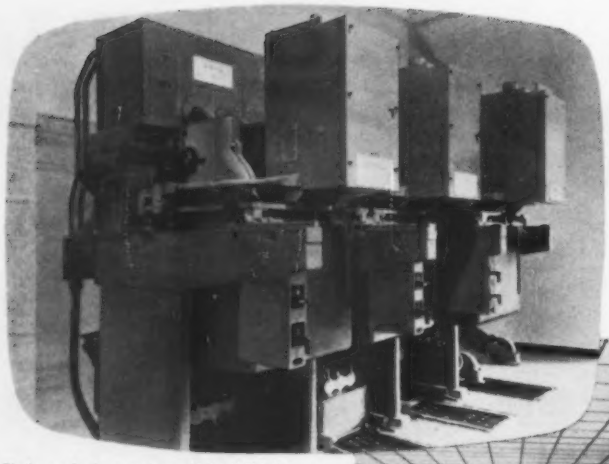
generator switchgear at Calder Hall



Photographs by courtesy of the U.K.A.E.A.

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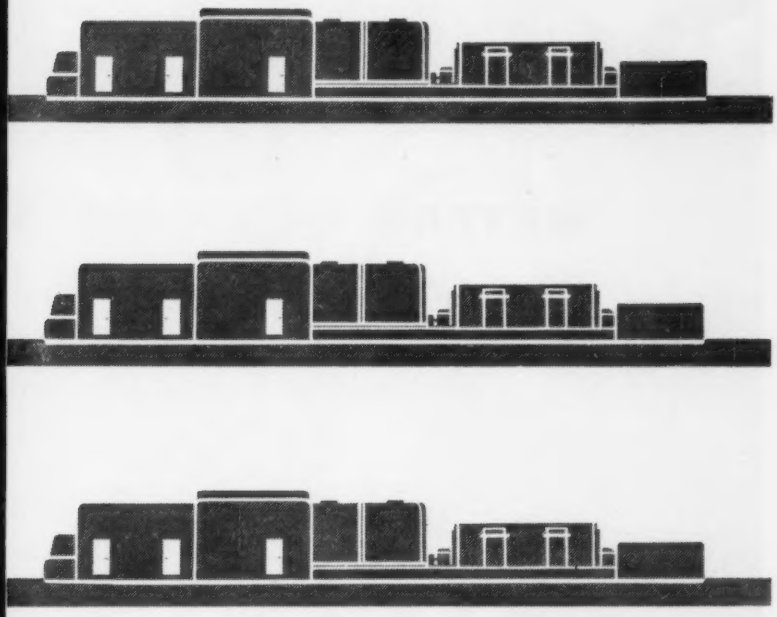

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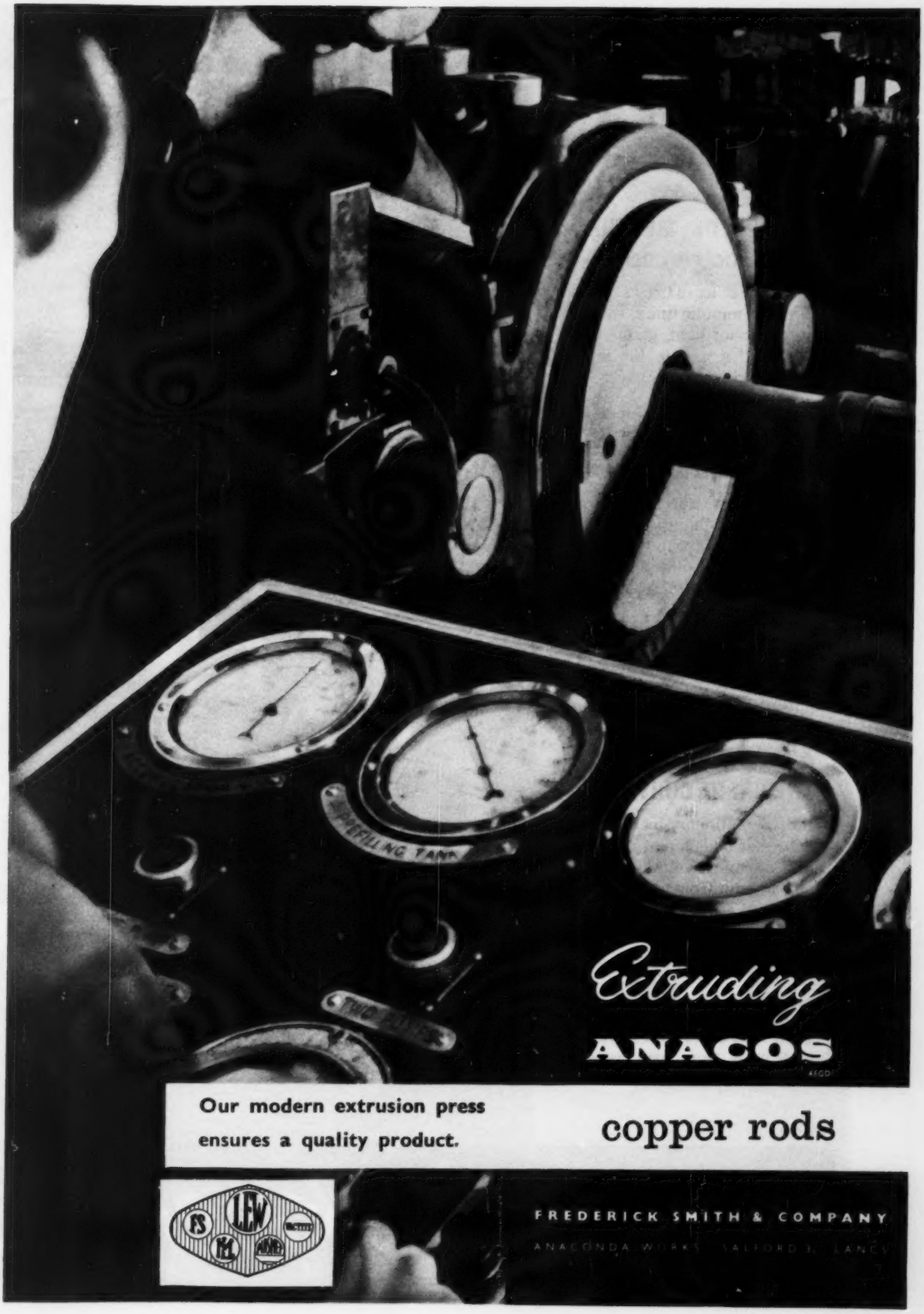
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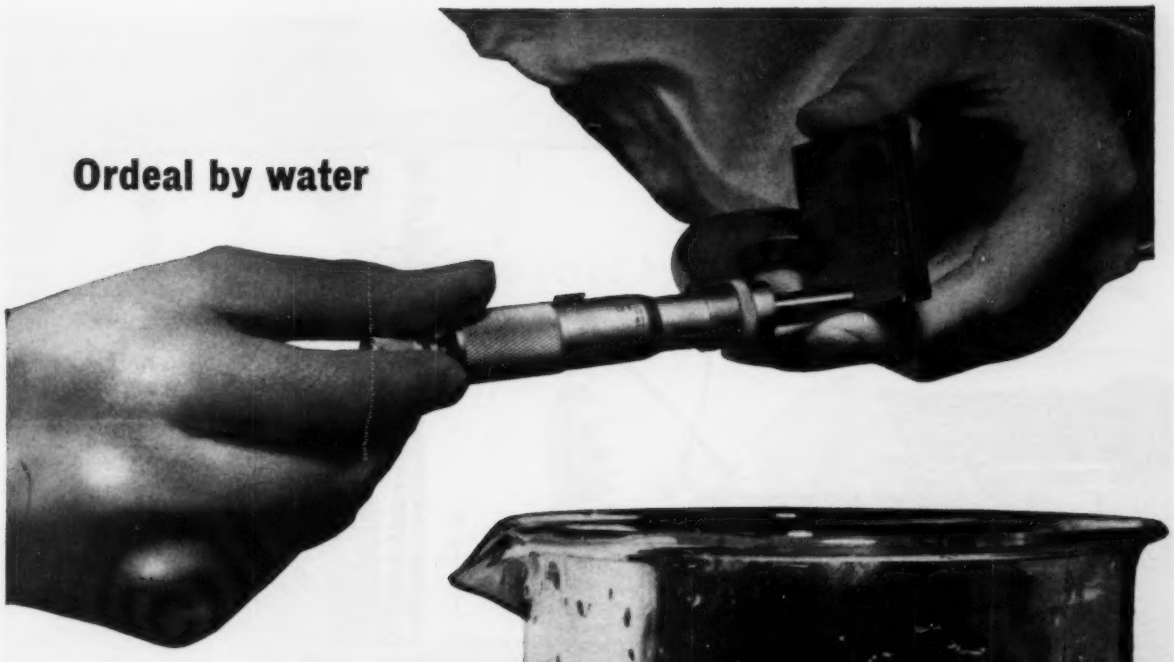

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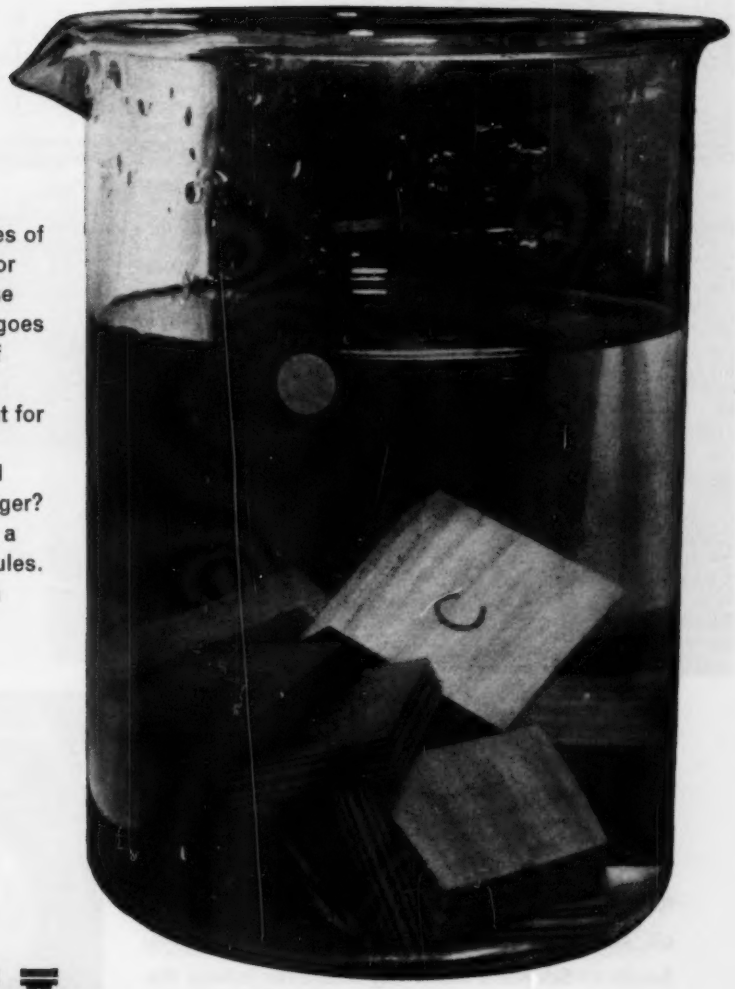

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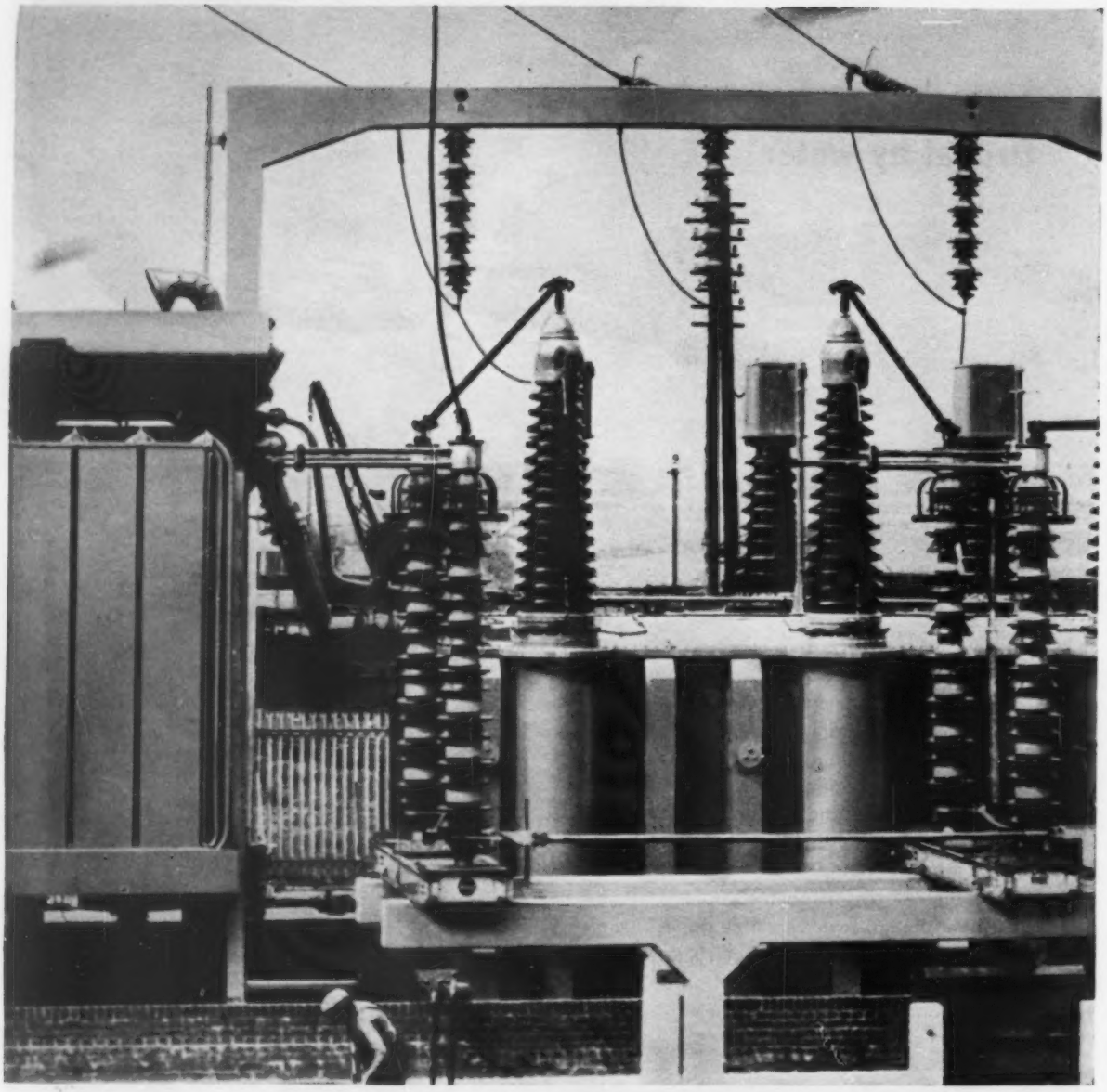

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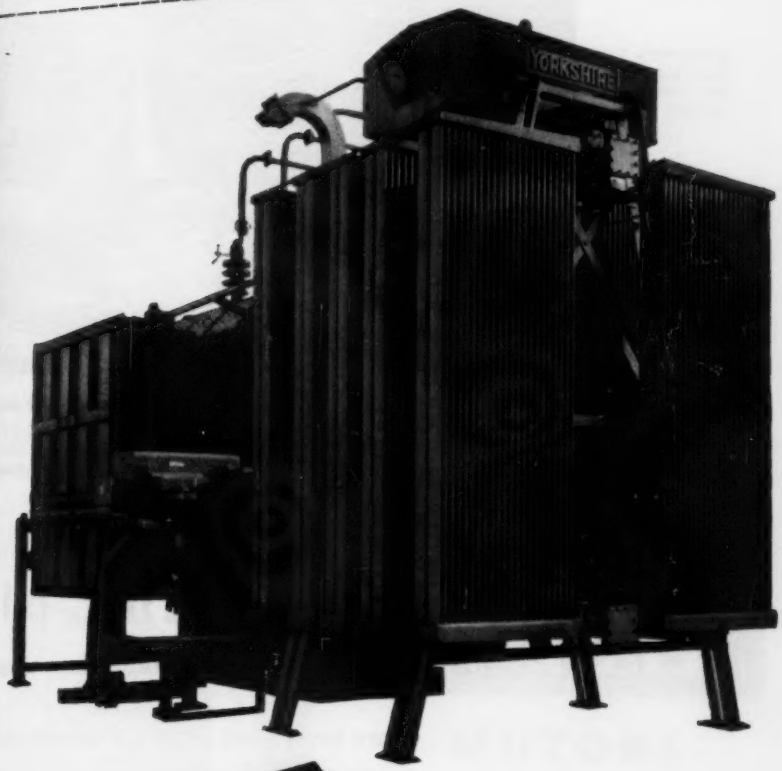

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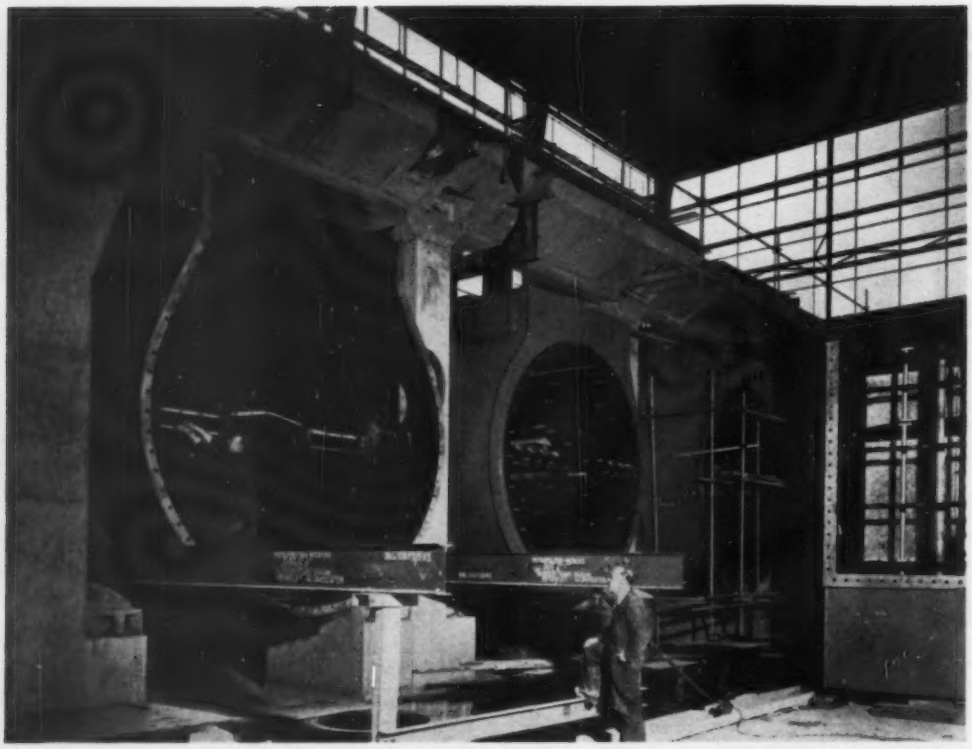

A view of one of four triple shell condensers being installed with A.E.I. turbine generators at Berkeley Power Station. (Photograph by courtesy of A.E.I. Ltd., formerly Metropolitan-Vickers Electrical Company Limited.)

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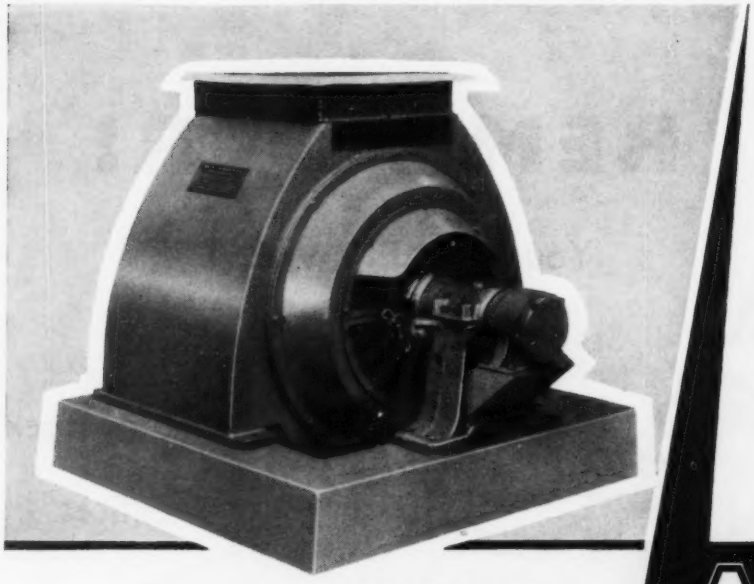

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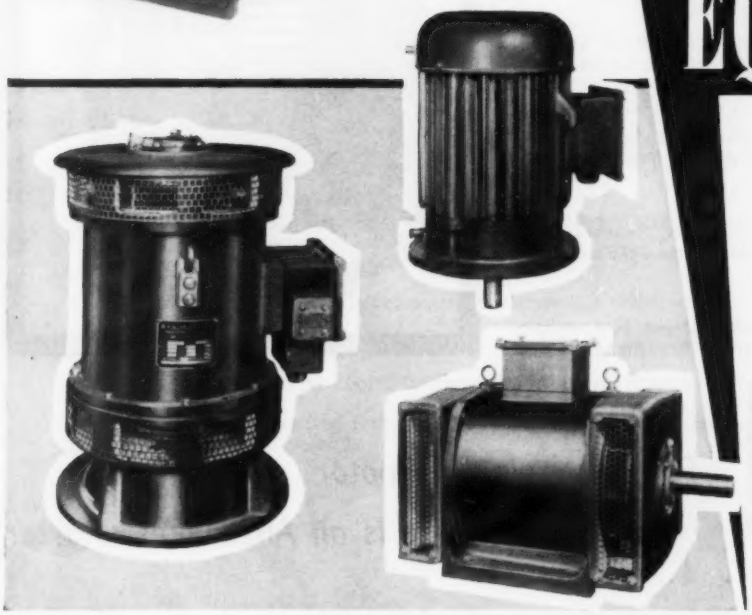

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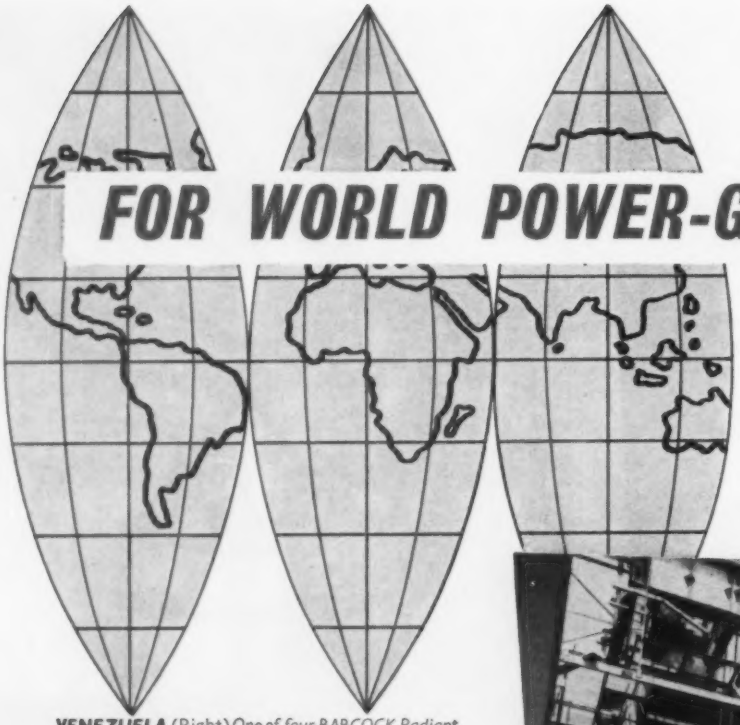

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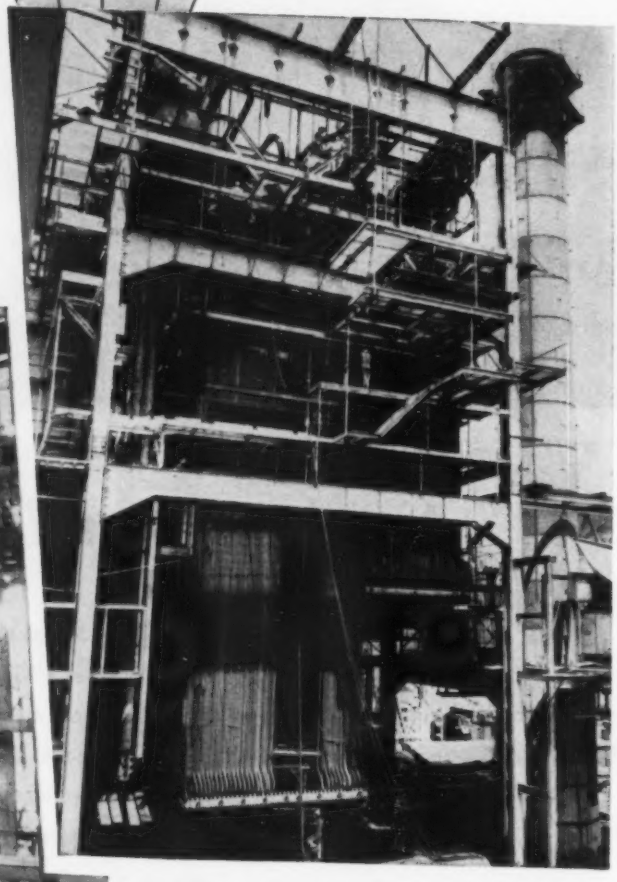

VENEZUELA (Right) *One of four BABCOCK Radiant boilers, natural-gas and oil fired, each rated at 550,000 lb./hr.; during erection for La Electricidad de Caracas. (Consulting Engineers: Sofina)*

AUSTRALIA (Below) *One of three BABCOCK Radiant boilers, each rated at 550,000 lb./hr.; during erection at Wangi power station, N.S.W., which has a total of nine BABCOCK boilers.*

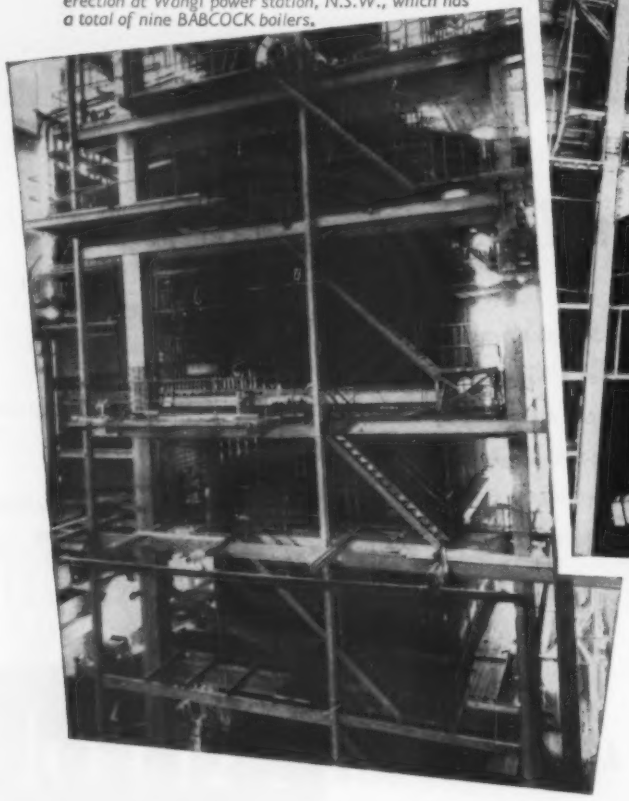

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Illustration shows a Type 4 2,000 h.p. "English Electric" diesel-electric locomotive on the Eastern Region of British Railways.

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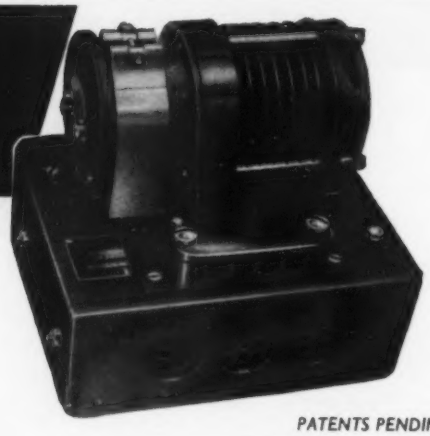

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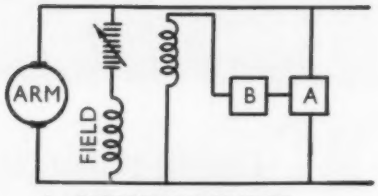

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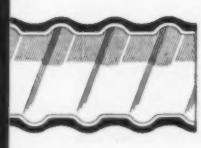
SEAMLESS
ALUMINIUM



PROTECTIVE SERVING

Anti-corrosion protection is provided by an extruded P.V.C. covering which fits tightly over the whole sheath surface. *See section view.*

INSTALLATION

Conventional installation procedure is followed. Jointing techniques are the same as for normal smooth aluminium-sheathed cables.

CABLE TYPES

C.S.A. sheathing is available with BICC Mass - Impregnated Non - Draining (M.I.N.D.) Cables up to 33kV and for Oil-Filled Cables.

BRITISH INSULATED CALLENDER'S CABLES LIMITED 21 BLOOMSBURY STREET LONDON W C 1

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Here is vital news for industry! BOAC's new slashed air cargo rates between Britain and U.S.A. and Canada make air shipment an even more economic proposition. Ring your BOAC Forwarding Agent or any BOAC office for full details NOW, if your consignments fall within any of these categories:—

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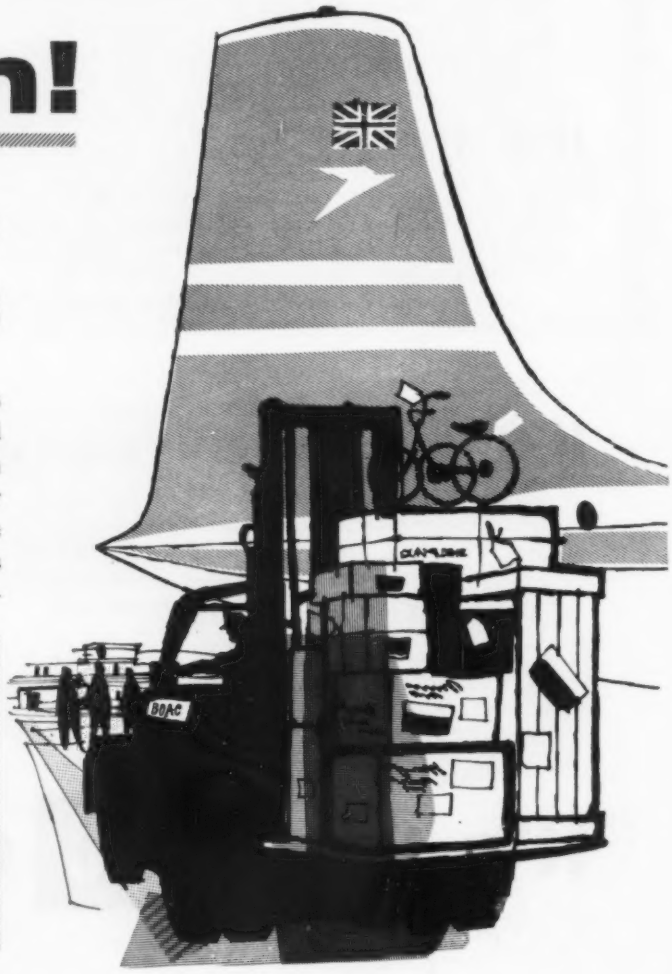


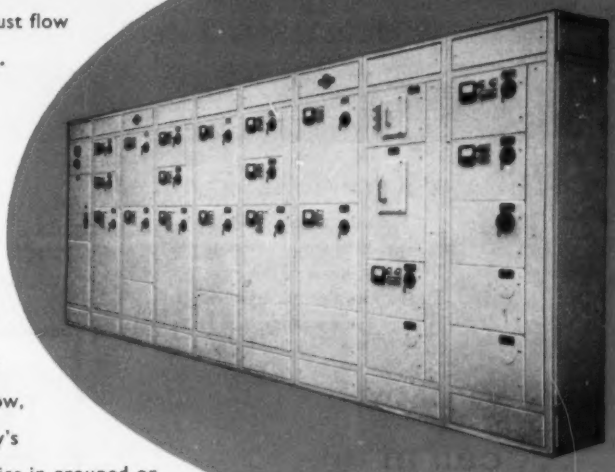
B·O·A·C gives your cargo jet-age handling

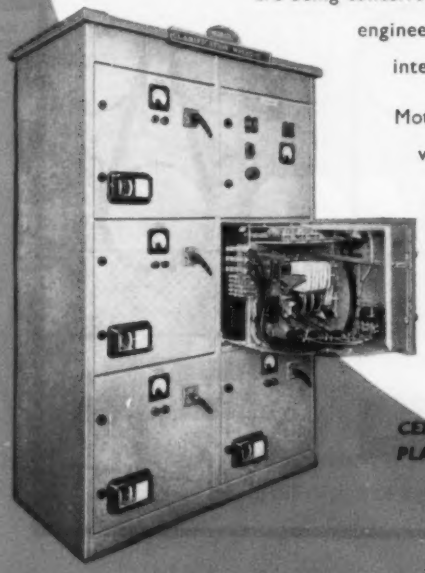
BRITISH OVERSEAS AIRWAYS CORPORATION

Controlling the flow

Production must flow in a steady stream . . . from material and component stock, through machinery or processing, to the finished stage.

The conveyors that speed this stream, the machines it feeds, the processing plant through which it passes . . . these, and the many main or ancillary equipments that serve the flow, are being conceived by today's engineers as studies in grouped or integrated control.





Motor control centres by Brookhirst Igranic, who give consultant service on control problems, are integrally reliable, easy to install and maintain, with easily interchangeable units, and easily modified or extended.

CENTRALISED, STANDARDISED PLANT & PROCESS CONTROL with Brookhirst Igranic motor control centres

BTH

Metal Industries Group

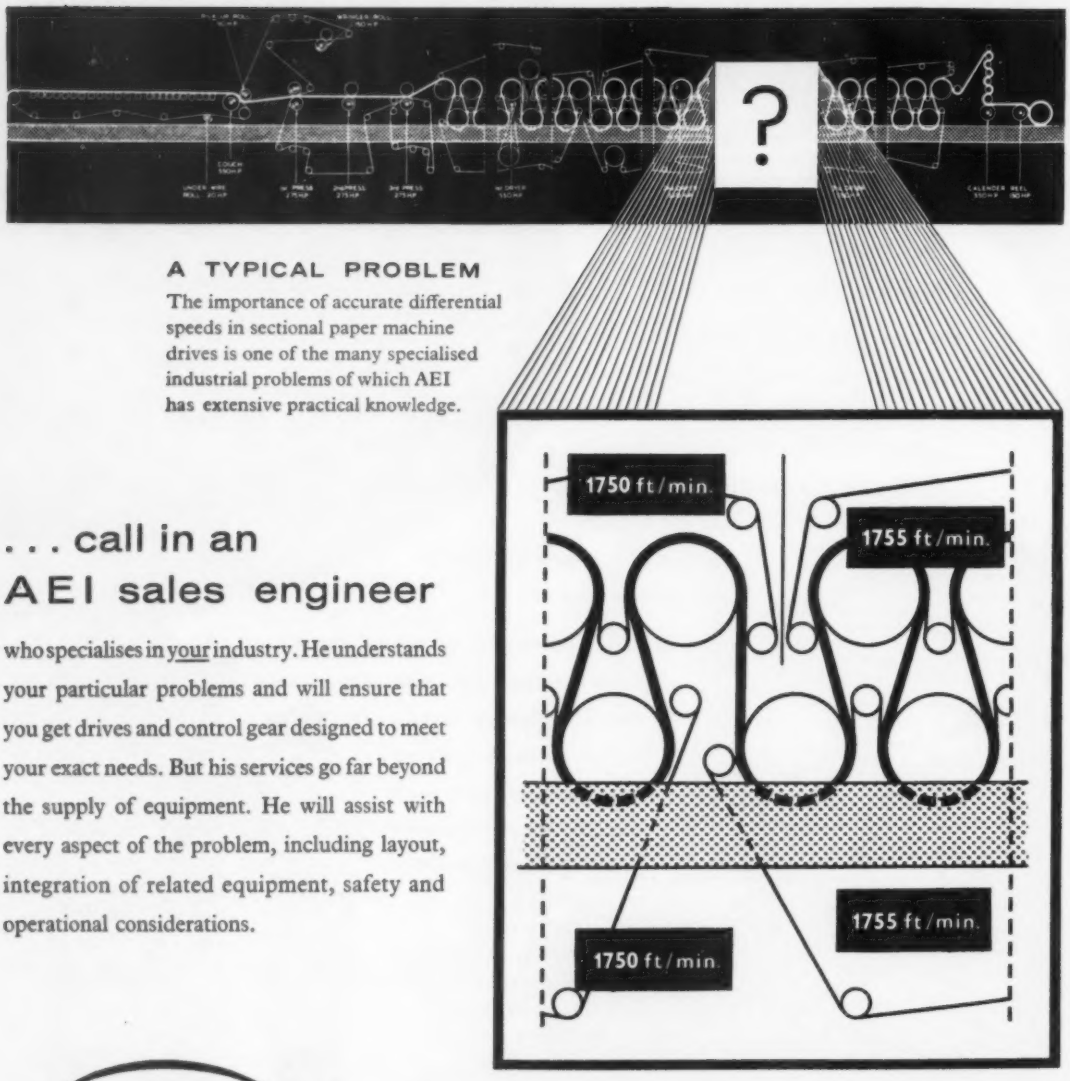
BROOKHIRST IGRANIC LIMITED

Sales Headquarters: BEDFORD WORKS · BEDFORD · *Works at:* BEDFORD & CHESTER

Area Offices: Birmingham Bristol Cardiff East Anglia Glasgow Leeds London Manchester Mid-Southern Newcastle Nottingham Sheffield Belfast

Makers of Britain's widest range of electrical control and associated equipment

When you need more than just a motor...



A TYPICAL PROBLEM

The importance of accurate differential speeds in sectional paper machine drives is one of the many specialised industrial problems of which AEI has extensive practical knowledge.

. . . call in an AEI sales engineer

who specialises in your industry. He understands your particular problems and will ensure that you get drives and control gear designed to meet your exact needs. But his services go far beyond the supply of equipment. He will assist with every aspect of the problem, including layout, integration of related equipment, safety and operational considerations.

AEI **Associated Electrical Industries Limited**
Motor and Control Gear Division
RUGBY & MANCHESTER, ENGLAND

INCORPORATING THE MOTOR AND CONTROL GEAR INTERESTS OF BTH AND M-V

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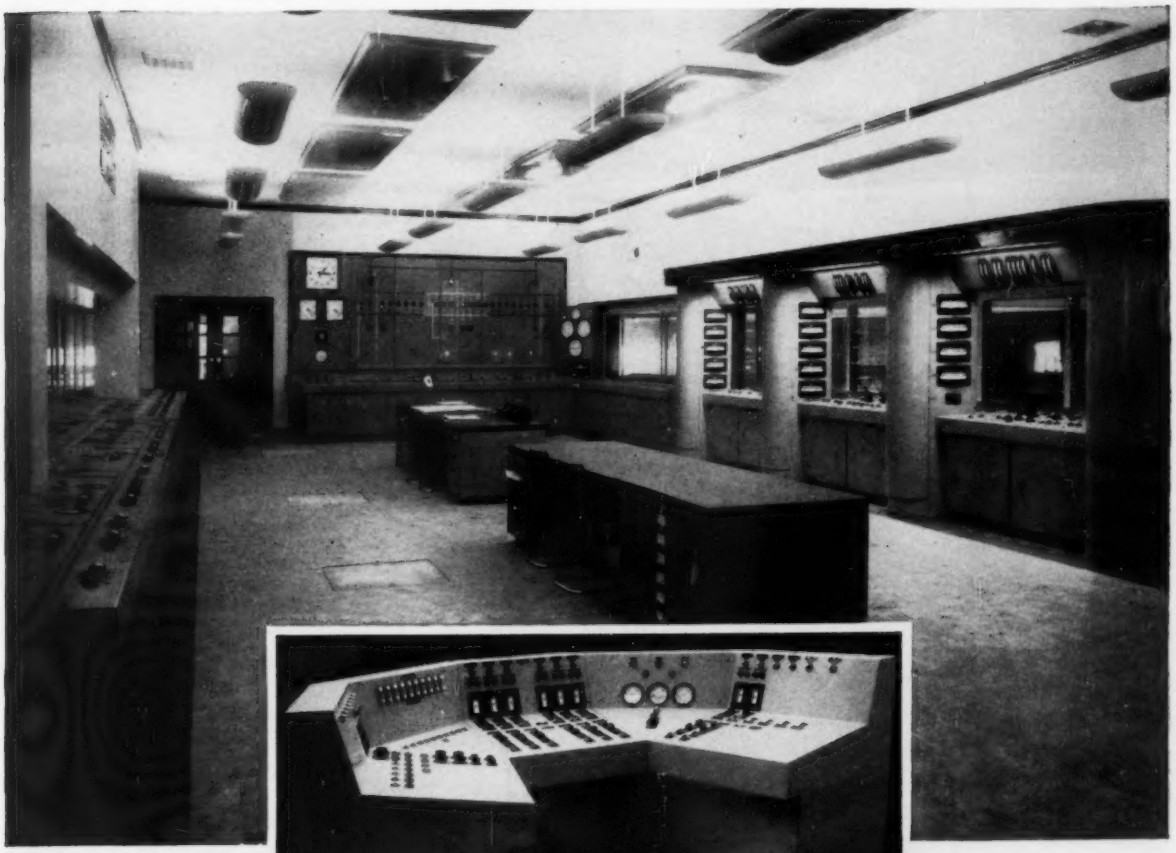
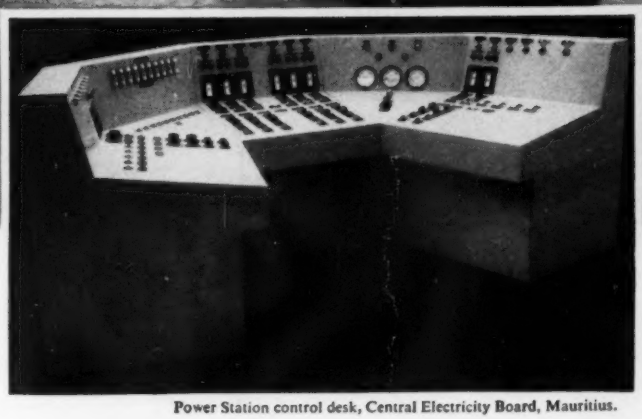


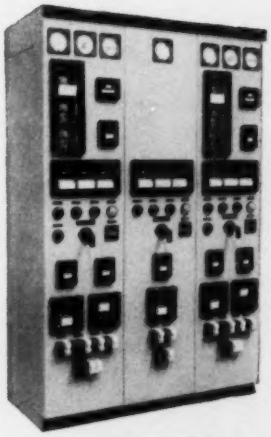
Main Control Room, Ashford Common Pumping Station of the Metropolitan Water Board.



Power Station control desk, Central Electricity Board, Mauritius.

Brush have considerable experience in the manufacture of Remote Control Boards for centralized operation and indication for power equipment.

Our Switchgear Division is always pleased to co-operate with project engineers and architects in the design of equipment for all applications.



Control and relay cubicles for industrial application.

BRUSH

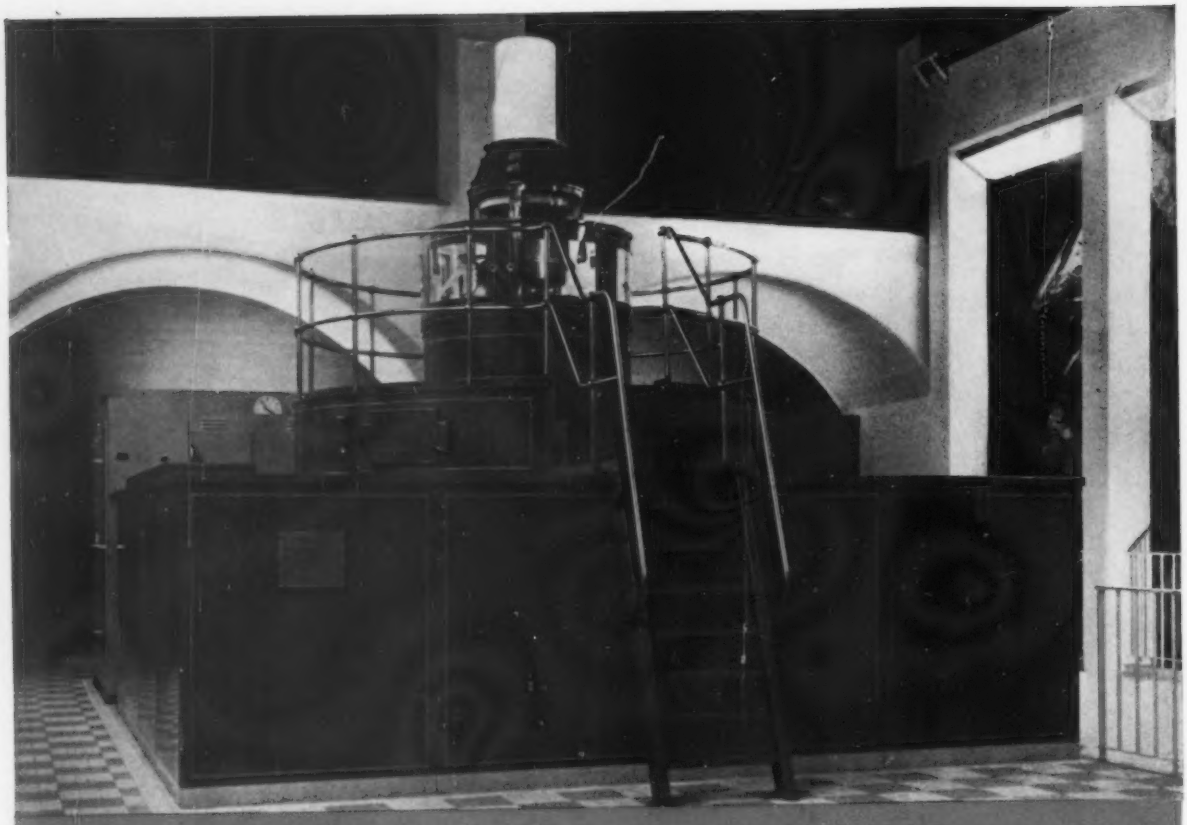
REMOTE CONTROL BOARDS

for power control of

SWITCHGEAR

BRUSH ELECTRICAL ENGINEERING CO. LTD. LOUGHBOROUGH, ENGLAND *(Member of the Hawker Siddeley Group)*

S6



Interior of St. Fillans underground power station of the North of Scotland Hydro-Electric Board showing a 21 MW 11 kV 600 r.p.m. vertical generator.

Hydro - Electric Plant

Bruce Peebles build large and small generators, horizontal and vertical types, designed to individual specifications, and transformers up to the largest sizes and highest voltages for hydro-electric power distribution.

25 MVA 11/132 kV transformer at St. Fillans power station

BRUCE PEEBLES
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STANDARD CAPACITORS

The Bushing Co. Ltd. manufactures a range of compressed gas capacitors intended for use as comparison standards for the measurement of capacitance and dielectric loss factor. The capacitors are constant in value and virtually loss-free.

The gaseous insulant is dry, oxygen-free nitrogen at a pressure of 10 atmospheres and freedom from losses and invariance of capacity is ensured by the design and screening of the electrodes.

The sizes available range from 50kV to 500kV and both 50pF and 100pF capacitors are available in each size.

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First Steps

First steps are important in all walks of life, as this fox cub emerging from his parental "earth" is already instinctively aware. And if he takes the wrong turning he can land up in serious trouble.

In fan engineering, as in nature, the choice of the better alternative is rarely an easy one to make.

If you have in mind an application involving the movement of air or other gases, the name "Sirocco" is synonymous with a great deal of hard won experience that is freely yours for the asking.

You are invited, as a first step, to take advantage of our 75 years of experience and our unrivalled design, manufacturing and testing resources by contacting our nearest Branch.

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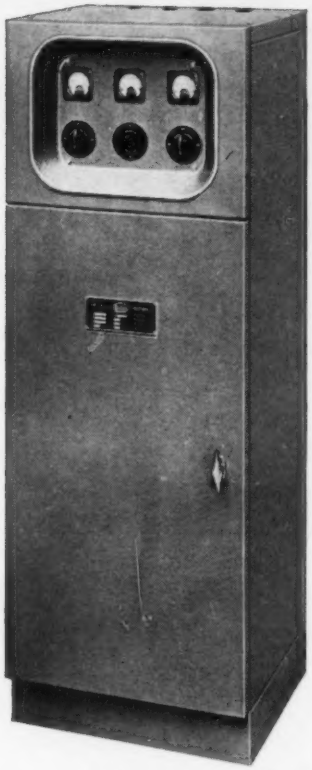
THE NEW TUDOR 'SAFETYLYTE' EMERGENCY LIGHTING EQUIPMENT



There is now an advanced version of the well-established Tudor 'Safetylyte' Emergency Lighting Equipment – the equipment that springs automatically into action the moment any interruption occurs in the normal mains supply, and provides emergency lighting protection in any type of public building.

This advanced equipment makes full use of the new Tudor High Performance Cell, and is housed in a cubicle of improved design. The larger cubicles are now constructed of folded sheet steel with the instrument panel recessed and the front door hinged to give ready access to internal components.

The equipment is available in both maintained and non-maintained types. For small lighting loads, wall-mounted cubicles (employing automatic mercury relay in place of a contactor) can be supplied. Self-contained trickle charge/floating battery equipment has also been designed for small buildings.

Tudor SAFETYLYTE

EMERGENCY LIGHTING EQUIPMENT

THE D.P. BATTERY COMPANY LIMITED
MANUFACTURERS OF KATHANODE AND TUDOR BATTERIES
BAKEWELL, DERBYSHIRE · TELEPHONE: BAKEWELL 581-5

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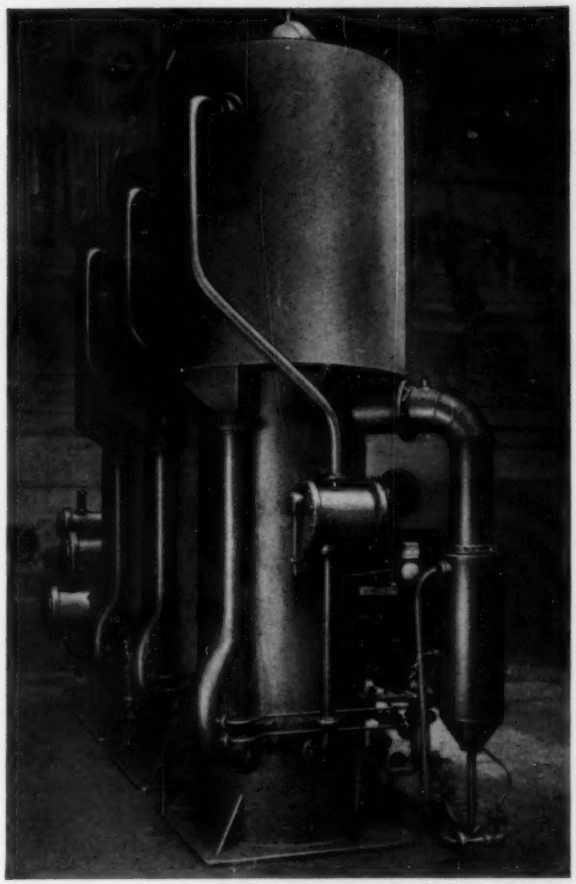


Triple effect re-compression type evaporator for 25,000 lb/hr. feed water

Evaporating Plant

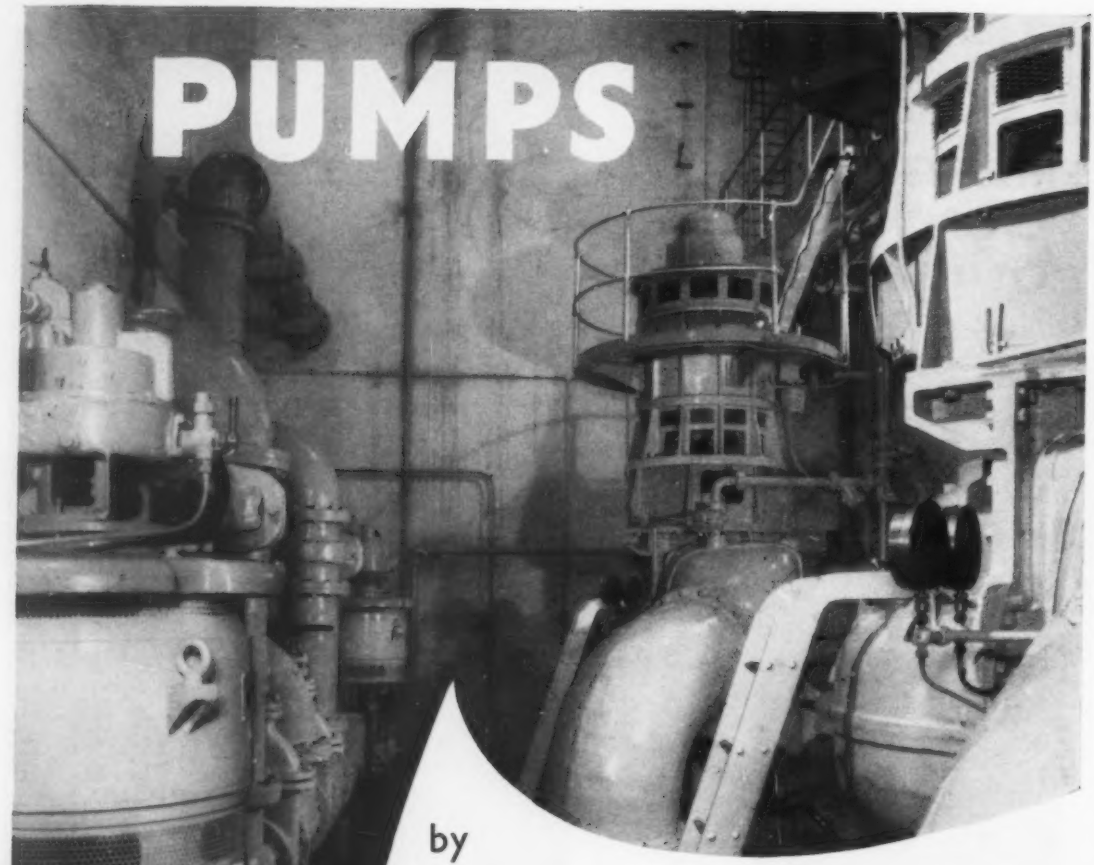
The trend towards higher boiler pressures and temperatures creates a need for greater purity of the feed water. Whilst the bled steam unit evaporator, incorporated in the feed system, is economically the best source of pure water for sets with a fairly steady load factor, independent central evaporating plant (incorporating vapour re-compression for economy) has many advantages, particularly for intermittent operation.

Hick Hargreaves supply bled steam unit evaporators, also vapour re-compression central plants in single, double, or triple effect of capacities up to 40,000 lb/hour (18,000 kgs/hour).

Hick Hargreaves

AND COMPANY LTD · BOLTON

H 152



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for high efficiency and constant reliability

Service before sales

Our Research and Development department is constantly engaged on applied research in Fluid Mechanics and other branches of engineering science.
In addition every facility is availab'e for the experimental investigation of problems directly concerning any specific pumping application. A fund of experience is available for customers' information ensuring the most efficient and economical pumping service.

After sales service

After sales service is an important function of the Drysdale organisation. An active staff of service engineers and technical representatives is available for short notice, free advice, on the spot service, to ensure Drysdale auxiliaries operate at peak performance.

DRYSDALE & Co Ltd.
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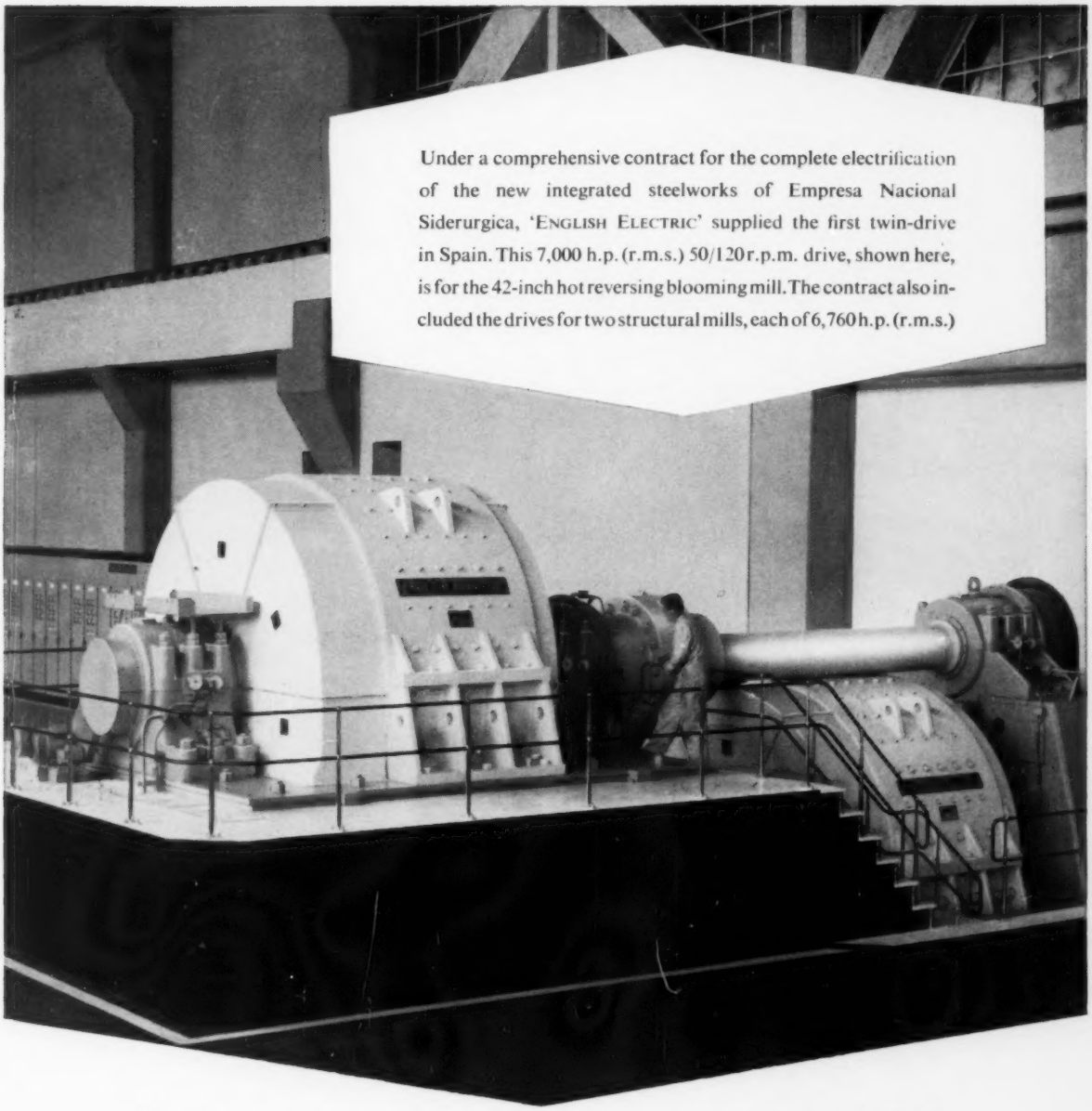
PUMP MAKERS FOR LAND AND MARINE SERVICES FOR OVER 85 YEARS

Printed for the Proprietors, THE BRITISH ELECTRICAL AND ALLIED MANUFACTURERS' ASSOCIATION (INCORPORATED), by WILLIAMS, LEA & CO., LTD., Clifton House, Worship Street, London, E.C.2.



Under a comprehensive contract for the complete electrification of the new integrated steelworks of Empresa Nacional Siderurgica, 'ENGLISH ELECTRIC' supplied the first twin-drive in Spain. This 7,000 h.p. (r.m.s.) 50/120 r.p.m. drive, shown here, is for the 42-inch hot reversing blooming mill. The contract also included the drives for two structural mills, each of 6,760 h.p. (r.m.s.)

'ENGLISH ELECTRIC'

Power generation · Power transmission · Power control · Power distribution
Power transformation · Power conversion · Power utilisation · Power measurement

Power is our Business

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Partners in Progress with NAPIER, MARCONI'S, VULCAN FOUNDRY and ROBERT STEPHENSON & HAWTHORNS
in The ENGLISH ELECTRIC Group

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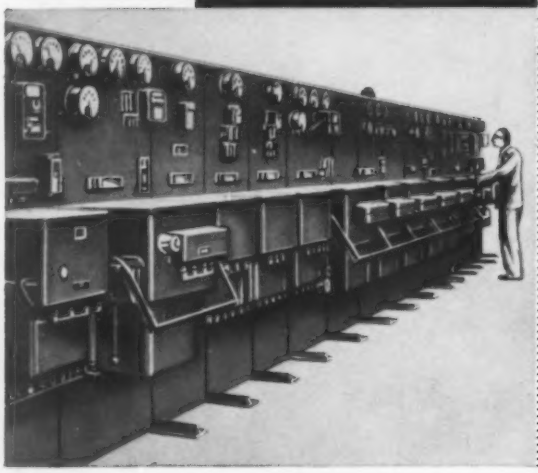
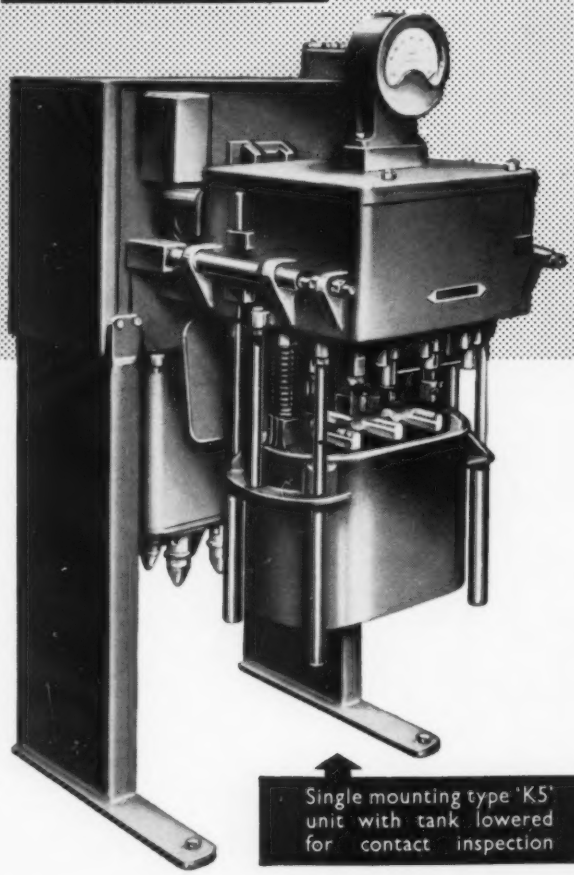
TYPES K & KC

Industrial Switchgear

Rating—up to 660v./2000a.



Switchboard consisting of types 'KC6' and 'KC4' units



Single mounting type 'K5' unit with tank lowered for contact inspection

Types K & KC Switchgear have been specially designed to provide a reliable power supply for industrial and commercial needs where the rating required is not in excess of 660V-2000A.

The Switchgear is available for pedestal or cubicle mounting and incorporates horizontal drawout circuit-breakers suitable for the control of all main and auxiliary power supplies.

Their unit construction permits single or switchboard mounting to meet individual requirements.

For further particulars write to AEI Switchgear Division, Higher Openshaw, Manchester, or to your local AEI office.

AEI SWITCHGEAR DIVISION

Associated Electrical Industries Limited

Higher Openshaw, Manchester · Trafford Park, Manchester · Willesden, London

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